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# Southwest
## FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

## REPORT OF ACTIVITIES November-December1991

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# ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

**Plans made for 1991-92 AMLR Field Season**

In support of the U.S. Antarctic Marine Living Resources (AMLR) program, the Antarctic Ecosystem Research Group (AERG) has been preparing for the program's annual field season in the Antarctic. As in past seasons, research is being conducted in the vicinity of Elephant Island at the tip of the Antarctic Peninsula. The field effort is to include research conducted from aboard the NOAA ship *Surveyor* and from a field camp on Seal Island, a small island off the coast of Elephant Island. This field effort will complete a cooperative study between the United States and Chili to census seal and penguin populations in the peninsula area.

**Seal Island Field Team**

The Seal Island field team, all from the National Marine Mammal Laboratory at Seattle, are led by Peter Boveng and include Don Croll, Mike Goebel, John Jansen, Scott Manley, and Hector Douglas. M. Shin of the Korea Antarctic Research Program is participating in seal research during part of the season.

Arriving at Seal Island on December 2 aboard the tourist ship *World Discoverer*, the Seal Island party began studying reproductive and foraging behavior in krill predators. The field party found that all camp supplies and structures overwintered well though the considerable quantity of snow in the camp slowed the process of setting up the tent used for primary living quarters. Time-depth recorders and radio transmitters were placed on furseals, and counts of penguins in breeding colonies were begun.

**The *Surveyor***

The *Surveyor* departed from Seattle on December 13, 1991, and arrived in San Diego on December 17 to load scientific supplies and equipment in preparation for its two-leg trip. The ship, scheduled for arrival in Punta Arenas, Chile, on January 12, 1992, transited the Drake Passage to the Antarctic Peninsula. Each of the two legs of the trip will last approximately one month and will be separated by a 5-day port call. During each leg, a broad-scale survey will be attempted in order to map the major features of the distribution of water masses, primary production, and krill. Using a detailed survey, biologists will map the distribution of krill north of Elephant Island. In addition, two or more cross-shelf transects of close-spaced CTD/rosette casts and net-sampling stations are to be completed and intensive samples of localized areas of high krill density are to be made. Observations will include the following: 1) thermohaline structure, available radiance, and light transmissions in the upper water column, 2) phytoplankton biomass, primary productivity and nutrient content, and 3) krill distribution, demography, and physiological condition. Additional operations include 1) collection of continuous sea-surface temperature, salinity, chl-a fluorescence, air temperature, barometric pressure, wind speed and direction, light levels, and 2) trace-nutrient limitation experiments.

Fishery Biologists Roger Hewitt and Rennie Holt of the Antarctic Ecosystem Research Group (AERG) will be cruise leaders aboard the *Surveyor* during the first and second legs, respectively, and AERG Ocean Acoustics Engineer David Demer, Operations Research Analyst Stephanie Sexton, and Biological Technician Jane Rosenberg will be participating in conducting hydroacoustic surveys for krill. Anthony Amos, University of Texas at Austin, is to be the principal investigator on oceanographic studies; Osmund Holm-Hansen, Scripps Institution of Oceanography, will be conducting phytoplankton/primary productivity studies; and Valerie Loeb, Moss Landing Marine Laboratories, and John Wormuth, Texas A&M University, will be in charge of studies associated with direct krill sampling. In addition, oceanographers from two Chilean universities and the Instituto Hidrografico de la Armada (IHA) will launch a series of bathythermographs during transits of the Drake Passage.

From January 14 to 29, 1992, John Bengston, National Marine Mammal Laboratory, will conduct a joint United States-Chilean pinniped and seabird census. The research is to be conducted using the Chilean vessel *Alcazar*. The party will launch Zodiac boats to survey beaches in the South Shetland Islands. Estimates of population abundance for seals will be provided to the Commission for Conservation of Antarctic Marine Living Resources (CCAMLR) as part of a time series based on surveys conducted at approximately 5-year intervals.

The U. S. Antarctic Marine Living Resources program provides information needed to formulate U. S. policy on the conservation and international management of resources living in the oceans sur-

rounding Antarctica. The program advises the U.S. delegation to the Commission for Conservation of Antarctic Marine Living Resources (CCAMLR), which is part of the Antarctic treaty system. (J. Rosenberg, FTS 893-5600)

## COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

### The Spawning Frequency and Batch Fecundity of Chub Mackerel

Terri Dickerson, California Department of Fish and Game, and Fishery Biologists Beverly J. Macewicz and J. Roe Hunter have completed a manuscript on the spawning frequency and batch fecundity of chub mackerel, *Scomber japonicus*. The manuscript will be submitted to the California Cooperative Oceanic Fisheries Investigations (CalCOFI) Reports for publication in Volume 33, 1992. The results of their research on spawning frequency and batch fecundity indicate that the average *S. japonicus* female spawned 8.8 times during 101 days of the 1985 spawning season. It was clear that individual females did not spawn at regular intervals over this period but that many spawnings occurred in rapid succession. In 32 females having ovaries with multiple spawning stages, the average interval between the spawns was 1.3 days.

The average batch fecundity for 13 females was 68,000 oocytes, or 168 oocytes per gram of female weight. Mean batch fecundity was multiplied by the average number of spawns (8.8) to determine that the average 444-g female spawned about 126,000 oocytes per season. The standing stock of advanced-yolk oocytes, considered by MacGregor to be the annual fecundity of *S. japonicus*, was only a fifth of 126,000. Clearly, the standing stock of advanced-yolk oocytes is not a good indicator of the potential annual fecundity of *S. japonicus* and annual fecundity should be considered to be indeterminate, with eggs being continuously recruited to the ovary.

The prevalence of ovarian atresia was most striking. Females with highly atretic ovaries were common throughout the spawning season. This condition is prevalent in anchovy only near the end of the season when spawning is declining for the stock as a whole. The prevalence of atresia throughout the spawning season indicated to these authors that the spawning cycles of *S. japonicus* are not synchronized for the stock as a whole but seem to vary from sample to sample. This seems to be a common trait in the reproduction of scombroid fishes in general, and such tendencies have been noted in Atlantic mackerel and yellowfin tuna. The most plausible explanation of the patchiness of spawning and postspawning *S. japonicus* is that schools segregate according to the reproductive traits, with spawning schools occupying areas different from those occupied by postspawning schools. (J.R. Hunter, FTS 893-7127)

### North Pacific Albacore Ecology and Oceanography

"North Pacific Albacore Ecology and Oceanography," a manuscript by Oceanographers R. Michael Laurs and Ronald J. Lynn, has been submitted and accepted for publication in the National Oceanic and Atmospheric Administration (NOAA) Technical Report series. The report summarizes a broad range of knowledge of albacore ecology and associated oceanography in the North Pacific that has resulted from almost 2 decades of studies conducted by the fisheries oceanography group at the Southwest Fisheries Science Center (SWFSC) at La Jolla. It briefly reviews 1) the characteristics of the major North Pacific fisheries for albacore, including catch distribution and recent redistribution of effort; 2) stock structure, including the concept of two subgroups; 3) migration based largely upon an extensive tagging program; 4) physiological ecology and habitat definition which cover results of clinical studies, acoustic tracking, and satellite remote-sensing studies; 5) food habits; and 6) the relation of migration and catch distribution to mesoscale and large-scale oceanographic fronts. This last subject is dealt with in greater detail than in previous publications.

The major centers of catch for the U. S. jig and baitboat fishery and the Japanese longline and baitboat fisheries are shown in Figure 1. Each is averaged over a period identified in the figure. Their geographic positions are clearly related to the mean positions of the major zonal ocean fronts shown in Figure 2, and their seasonal development is related to the seasonal progression of warming shown in Figure 3. The majority of albacore are caught where surface temperature is within the range of 16° to 18° C despite the fact that they spend most of the time within the cooler waters of the thermocline beneath the surface layer. The longline

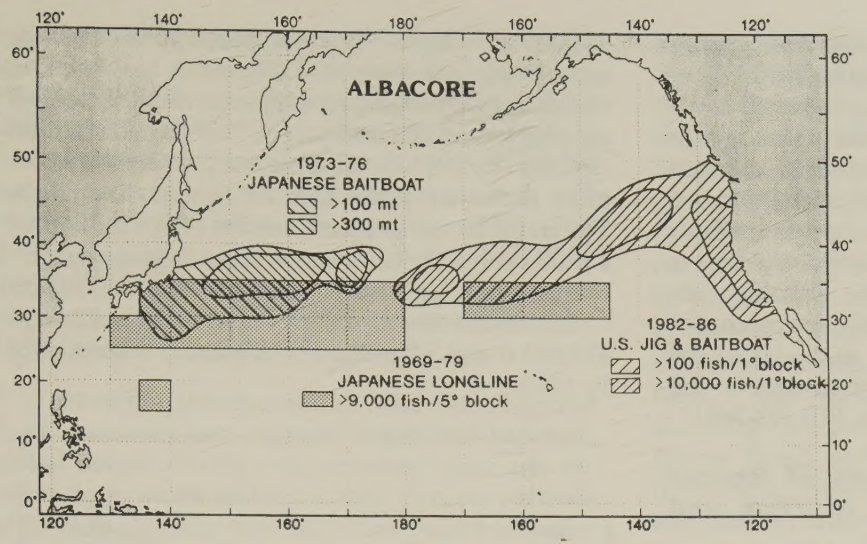


Figure 1. Major centers of catch for Japanese pole-and-line, longline, and U. S. jigboat fisheries. The contoured and shaded regions represent approximately 75% of total annual average for the years indicated for each fishery. The regions of heavy shading represent about 40% of the annual average catch.

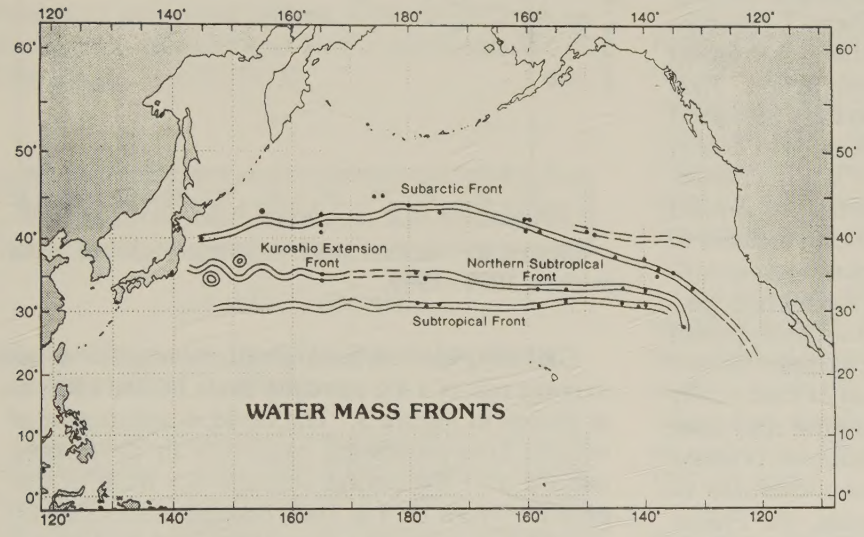


Figure 2. Schematic representation of the major fronts in the temperate zone of the North Pacific based upon numerous individual observations (dots). The transition zone lies between the fronts.

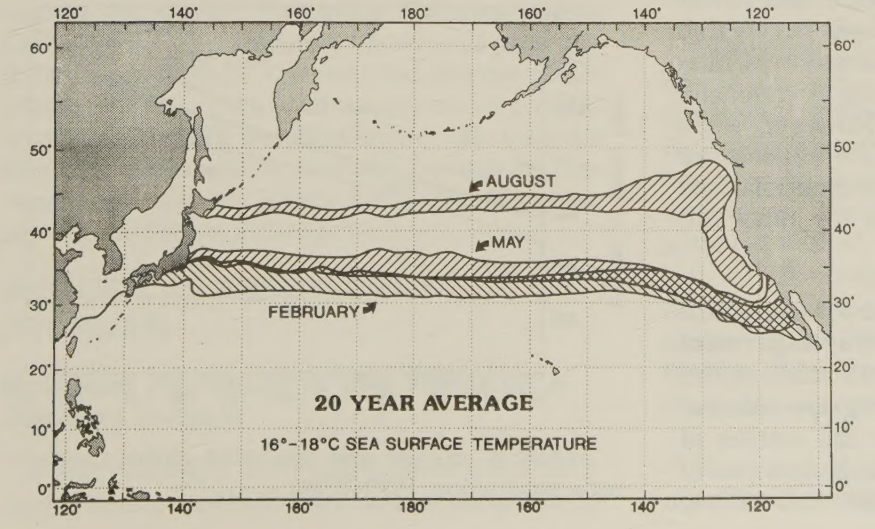


Figure 3. Distribution of the 20-year average sea surface bands of temperature between 16 and 18°C for February, May, and August.

fishery, centered about the subtropical front, is conducted during winter and is the most southerly of the fisheries. As spring warming progresses and a more shallow surface layer forms, the Japanese baitboat fishery develops about the Kuroshio Extension front, and there is a northward and eastward progression of catches. The U.S. jig and baitboat fishery develops last, in the mid Pacific, and moves eastward and northward with the warming. In summer, in the eastern North Pacific, the catches of this latter fishery develop north and east of the subarctic front and often concentrate close to the coastal upwelling fronts. (R. Lynn, FTS 893-7084)

### Updated Analysis Completed of Recent Trends in Global Catches of Tuna and Canned Tuna Production

Sam Herrick, industry economist at the La Jolla Laboratory, and Jeffery G. Lee, graduate student at the University of California, San Diego, have completed an updated analysis of recent trends in global catches of tuna and canned-tuna production. They find that worldwide catches of tuna have increased steadily from 1.648 million metric tons (t) in 1979 to 2.210 million t in 1989, an increase of 34% in 11 years. From 1979 to 1988, global production of canned tuna rose from 607,000 t to 877,000 t, an increase of 33%. While these increases in catches and canned-tuna production are impressive in themselves, perhaps more striking is the considerable development in the harvesting and canning capabilities in less-developed countries relative to that of historically dominant tuna-harvesting and canning countries; namely Japan, the United States, Spain, and France. The rapid development of tuna industries in southeast Asia (Thailand, Indonesia, the Philippines, Korea, Taiwan, Malaysia), India, China, Latin America (Mexico, Venezuela, Panama, Brazil), the island nations of the western Pacific, and Africa (Ghana and the Ivory Coast) has been largely due to their proximity to abundant tuna resources, relatively low-cost labor sources, strong government, and investments from abroad. However, while these are necessary conditions, the impetus for developing tuna industries in these areas relates to a growing worldwide demand for tuna and processed tuna products.

The linear-trend model in Figure 4 shows global tuna catches increasing at an annual average rate of 3.1% between 1979 and 1989, with most of this increase due to growth in the fishing operations of developing nations. Growth in the catches of developing nations increased at an annual rate of 4.7% over the period, from 594,000 t in 1979 to 904,000 t in 1989. This compares to an average annual growth rate of 2.2%, with much more variability for developed nations, with their catches ranging from 1.054 million t in 1979 to 1.306 million t in 1989. By 1986, developing nations accounted for more than half of the world's annual tuna catch. The trend model predicts catches of 3.1 million t ( 434,000 t) by 1999. The global catch-trend projection and 95% confidence bands are shown in Figure 4. Linear-developed nations' catch is 1.4 million t ( 414,000 t) and 1.7 million t ( 274,000 t) respectively by 1999.

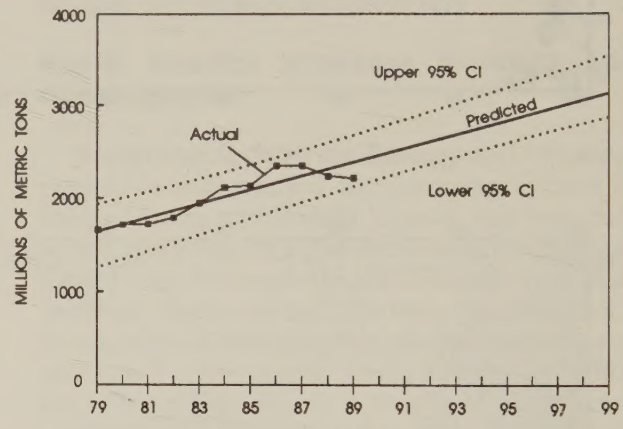


Figure 4. Actual and predicted global tuna catches, 1979 - 1999.

Globally, canned-tuna production grew at an average rate of 4.4% annually from 1979 to 1988, as is shown in Figure 5. The rapid development of canned tuna-processing capability in developing nations over the period accounts for most of this growth. From 1979 to 1985, canned production by developing nations increased 84%, with an average

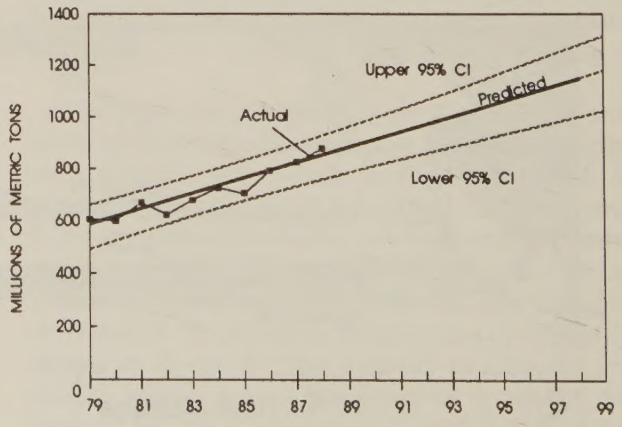


Figure 5. Actual and predicted global canned-tuna production, 1979-1998.

increase of 11% per year, compared to a 5% increase for developed nations, at an average annual rate of 1%. By 1985, the developing nations accounted for 22% of the world's annual canned-tuna production compared with 14% in 1979. The linear trend model for canned tuna predicts global production will reach 1.14 million t ( 139,000 t) by 1998. The developing nations' production is estimated to be 453,000 t ( 113,000 t), and production by developed nations is predicted to be 685,000 t ( 85,000 t) by 1998, based on linear trends estimated for each.

If prevailing trends continue, and assuming that tuna resources can support expanded harvests, global output of raw and processed tuna may increase by as much as 30% by 1999. If recent patterns of growth continue into the future, this expansion is likely to be led by developing nations with burgeoning tuna industries; in which case, the tuna industries of developed nations will continue to face more and more intense competition, both on the fishing grounds and in the marketplace. (S. Herrick, Jr., FTS 893-7111).

## MARINE MAMMAL DIVISION

La Jolla, California

### Marine Mammal Division Participates in International Conference

The Marine Mammal Division participated in the Ninth Biennial Conference on the Biology of Marine Mammals held December 5-9 in Chicago, Illinois. The Biennial Conference, the premier meeting for marine mammal scientists and managers, allows scientists to exchange ideas with researchers from around the world. Southwest Fisheries Science Center (SWFSC) scientists made several presentations in specialized sessions and during poster presentations. Presentations given by SWFSC scientists are briefly described below. Abstracts for the entire conference are available through the conference sponsor, the Society for Marine Mammalogy. (Joyce Sisson, FTS 893-7064)

## BIOLOGICAL ASSESSMENT PROGRAM

### Molecular Phylogeny of Two Forms of Common Dolphin

Fishery Biologist Andy Dizon presented preliminary results to the Ninth Biennial Conference on the Biology of Marine Mammals, held in Chicago, Illinois, December 5-9, that he and co-authors, Patricia Rosel of the Scripps Institution of Oceanography and John Heyning of the Los Angeles County Museum of Natural History, have found using genetic sequence information to differentiate between two types of *Delphinus delphis*. This species inhabits the waters off California and is known to be incidentally killed during commercial fishing operations. Morphologically, one type has a larger overall size; a larger skull; and a longer rostrum, or beak. Color pattern in adults can also be a distinguishing characteristic between the two types. Dizon, Rosel, and Heyning's investigation stems from the uncertainty existing among taxonomists and marine mammal managers as to the proper taxa level to apply to the two unique-but-overlapping forms inhabiting these waters.

Using the polymerase chain reaction; Dizon, Rosel, and Heyning amplified the control region of mtDNA from 20 samples and determined the nucleotide sequence of 440 base pairs spanning the most variable portion of the control region. Phylogenies were made using *Delphinus delphis* from the Black Sea in addition to *Orchinus orca* and *Cephalorhynchus commersonii* as outgroups.

The initial results of Dizon, Rosel, and Heyning's research indicate that for the region sequenced, the long-beaked form is genetically homogenous and distinct from the short-beaked form. They also found that the short-beaked form is more closely related to the Black Sea animals. (Andrew Dizon, FTS 893-7089)

### Relative Discreteness of Harbor Porpoise Stocks in the Northeast Pacific Determined from mtDNA Sequences

Patty Rosel, a graduate student at Scripps Institution of Oceanography, has been working in the Southwest Fisheries Science Center (SWFSC) Biological Assessment Program on differentiation between stocks of harbor porpoise using mtDNA techniques. Her presentation on this subject, co-authored with M. Haygood of the Scripps Institution of Oceanography, was selected as first runner-up for the best presentation by a graduate student at the Ninth Biennial Conference on the Biology of Marine Mammals, held in Chicago, Illinois, December 5-9.

Rosel and Haygood initiated their research in order to determine if it was possible to identify

discrete, genetically isolated populations of harbor porpoise in the Northeast Pacific. This species is known to have undergone high levels of incidental mortality throughout the world by becoming entangled in fishing gear; proper management of this species is dependent upon knowing the relative genetic discreteness of each harbor porpoise population. Rosel and Haygood have undertaken the task of characterizing the genetic composition of harbor porpoise stocks in the Northeast Pacific and determining, in particular, the degree of reproductive isolation between population centers located off the west coast of North America.

Using the polymerase chain reaction technique, they have amplified and sequenced a portion of the mtDNA control region (or displacement loop) from skin samples collected from stranded or incidentally caught animals from coastal waters off California and Washington. For comparison, samples were also obtained from harbor porpoise found in waters of the northeast and northwest Atlantic and in the Black Sea. Preliminary analysis of the data indicates that gene flow is limited between the Washington and California population centers and that the Black Sea population of harbor porpoise is genetically isolated from all other harbor porpoise populations. (P. Rosel, FTS 893-7095)

### Problems in Using Biological Indicators to Infer Changes in Population Abundance for the Eastern Tropical Pacific Dolphin Species

Fishery Biologist Sue Chivers presented a paper, co-authored with Wildlife Biologist Douglas DeMaster, at the Ninth Biennial Conference on the Biology of Marine Mammals, held in Chicago, Illinois, December 5-9, illustrating the problems with using biological indicators to infer changes in dolphin population abundance. The biological data collected on the dolphin species incidentally caught during tuna purse-seine fishing operations in the eastern tropical Pacific (ETP) were used for the analysis. Chivers and DeMaster hypothesized that the significant declines in abundance evident for populations of the central stock of the common dolphin, *Delphinus delphis*, and the eastern and whitebelly stocks of spinner dolphins, *Stenella longirostris*, would be positively correlated with the percentage of mature females pregnant and the percentage of mature females simultaneously pregnant and lactating. An index of population status was derived from the available information on trends in population abundance. The correlations with population status were as predicted for the central common and northern spotted dolphins, the two stocks that have a range of population status index of approximately 30% carrying capacity to capacity. For all the other stocks, the range of population status index was narrow and no correlations were found with life history data collected between 1974 and 1990; each of these stocks was reduced in population abundance well below 1000 before biological data were collected. As a result of these analyses, Chivers and DeMaster recommend that if biological indicators are to be used to monitor changes in population status, life history data collection must begin when the population is near carrying capacity. Biological indicators are also useful to corroborate changes in carrying capacity and are therefore valuable even if not initially collected when exploitation first begins. (S. Chivers, FTS 893-7093)

## PHOTOGRAMMETRY PROGRAM

### Use of Aerial Photography as a Tool for Assessing Marine Mammal Populations

#### Use of Aerial Photographs to Identify Common Dolphin Stocks

Fishery Biologist Wayne Perryman co-authored, with Wildlife Biologist Robin Westlake and Fishery Biologists Morgan Lynn and Jim Kilpatrick, an abstract and presented a poster entitled "Remote Identification of Dolphin Stocks with Vertical Aerial Photographs" at the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9. The abstract and poster represented their findings after having analyzed length data from vertical aerial photographs to determine whether discrimination could be made among the four stocks of common dolphins, *Delphinus delphis*, found in the eastern Pacific. Measurements were made on a STK stereo comparator. They found they could easily distinguish between the large, long-beaked neritic form and the much smaller, short-beaked common dolphins that occur sympatrically off Baja and southern California. Additionally, they found that common dolphins sampled within the central region were significantly longer than those from the northern or southern areas. Northern common dolphins were about 5 cm shorter on average than the southern animals, but the data were inconsistent. They also calculated birth month for calves, assuming linear growth during the first year, and found that reproduction appears to be pulsed in the north-

ern and southern regions and evenly distributed in the central area. (W. Perryman, FTS 893-7014)

### Use of Aerial Photography to Census Steller Sea Lions at Año Nuevo Island, July 1990/1991

Wildlife Biologist Robin Westlake presented a poster at the Ninth Biennial Conference on the Biology of Marine Mammals held December 5-9 in Chicago, Illinois, which she co-produced with Kathryn Ono, University of California at Santa Cruz, and with Fishery Biologists Wayne Perryman and Mark Lowry, describing how aerial photography can be used as an effective tool for monitoring populations of pinnipeds over time, especially in areas where access makes ground counts difficult. Photographic aerial survey and ground census of steller sea lions, *Eumetopias jubatus*, were conducted concurrently during the 1990 and 1991 breeding seasons at Año Nuevo Island, California. Three photogrammetrists independently counted all animals from the 5-inch format images and counts were very precise (coefficients of variation = 0.025-0.056). The counts from the aerial photos were consistently higher than ground counts for pups (3:1), adult females, and territorial males (1.5:1) although the latter category is somewhat subjective. Some areas were difficult to census from the island because of distant vantage points (100 m) and island topography. Comparison of photo and ground counts helps determine how well the two methods agree so that correction factors can be applied if only one method is used in future counts. Data from aerial photographs are not limited to counts, however. Measurements of the size of breeding individuals as well as information about other aspects of the social system can also be obtained from the photographs. (R. Westlake, FTS 893-7001)

### Variance of Photo-imagery by Readers

Fishery Biologist Jim Gilpatrick presented a poster to the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9, addressing the methods, precision, and consistency by which vertical aerial photographs of pelagic dolphin schools are counted by three readers at the SWFSC. Starting in 1987, annual eastern tropical Pacific (ETP) dolphin population surveys (otherwise known as Monitoring of Porpoise Stocks [MOPS]) were complemented with photographic sampling done with aerial reconnaissance cameras mounted on a Hughes 500-D helicopter. The helicopter is based aboard the NOAA ship *David Starr Jordan*. Because the mean of three independent dolphin-school-size photo estimates is used to calibrate the variable estimates made by shipboard observers, it is important that the sources and range of variance associated with photo counts be understood. Readers typically spend 2 to 5 hours per day for a period of 2 to 5 months per year counting dolphin images for school size estimates. One concern, addressed in the study by use of a repeated measures ANOVA, was that readers might change their methods over these months, resulting in a change in the accuracy and precision of counts over a period of time. Although results showed a significant reader with time interaction due to counts done at the start of the study, the contribution of this variance component to total variability over time was not significant. The analysis suggested that mean school size estimates taken from reader counts did not vary significantly with time and that a "warm up" counting session prior to the start of an annual reading period could improve the precision of counts at the start. The study showed that counts were precise with the coefficient of variation (CV) for schools read during the 1990 reading session ranging from 1.24% to 14.58% with 44 (or 92%) of the estimates having a CV less than 9.0%. The average percent error (APE) for individual readers ranged from 3.51% to 4.57%. (J. Gilpatrick, FTS 893-7195)

## DOLPHIN STOCK ASSESSMENT PROGRAM

### Trends in Dolphin Abundance in the Eastern Tropical Pacific, 1986-1990

Operations Research Analyst Tim Gerrodette presented a talk to the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9, which he co-authored with Fishery Biologists Paul Wade and Steve Reilly and with Wildlife Biologist Douglas DeMaster, regarding trends in dolphin abundance in the eastern tropical Pacific (ETP) from the 1986-1990 Monitoring of Porpoise Stocks Survey data. Annual surveys designed to estimate the relative abundance of dolphins in the ETP were carried out during 1986-90. The large-scale, stratified surveys utilized two ships for 4 months each year to cover a 19-million-square-kilometer study area. The surveys were designed to detect possible downward trends in abundance of four dolphin species, spotted, *Stenella attenuata;* spinner, *Stenella longirostris;* striped, *Stenella coeruleoalba;* and common, *Delphinus delphis*, due to mortality in tuna purse-seine fishing nets.

Densities of dolphin schools were estimated by line-transect analysis, and observer estimates of dolphin school size were calibrated by aerial photography. Estimates of abundance based on sighting rates were adjusted by the amount of suitable habitat available each year, computed from a multivariate analysis of oceanographic variables measured during each cruise. Preliminary analysis has not shown any decline in dolphin abundance during the study period 1986-1990. (T. Gerrodette, FTS 893-7064)

## FISHERY-DEPENDENT ANALYSIS PROGRAM

### Power to Detect Linear Trends in Dolphin Abundance: Estimates Derived from Tuna-vessel Observer Data 1975-1989

Fishery Biologist Elizabeth Edwards presented a talk to the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9, which she co-authored with Biological Statistician Cheryl Glick. Her talk dealt with the power of detecting trends in dolphin abundance using tuna-vessel observer data (TVOD). Weighted linear regressions were calculated by Edwards and Glick from 5-, 8-, and 10-year series of abundance indices for eight stocks of eastern tropical Pacific (ETP) dolphins. Power of conclusions about the absence of trend was calculated for those series with statistically insignificant regressions. The detectable trends were calculated for each series. Estimates of power and detectable trend were derived under two different assumptions about the correct sampling distribution (z and non-central t) and under two alternative hypotheses (one-sided or two-sided), in order to compare the relative effects of each type of analysis.

Power estimates for the eight stocks of eastern tropical Pacific (ETP) dolphin were low, reflecting the slight (or non-existent) trends apparent in most abundance indices. Detectability of trends increased with series length and with decreasing variability. For stocks with relatively abundant and consistently variable data (northern offshore dolphins), trends as small as 5% per year could be determined given a 10-year series of estimates. For stocks with relatively sparse and variable data (southern whitebelly spinner dolphins), detectable trends never decreased below about 25% per year, even for 10-year data series.

Based on these calculations, the ability to detect relatively small linear trends in dolphin abundance using tuna-vessel observer data (TVOD) will depend on utilizing data series close to at least a decade in length, even for stocks with well-behaved data. The most important implication of these results for management purposes is that, with these data, it may not be possible to statistically detect ecologically important decreases in abundance for those stocks with characteristically variable and sparse data. (E. Edwards, FTS 893-7099)

## NRC RESEARCH FELLOW

### Uses of Statistical Power in Conservation Biology: Detecting Trends in Abundance for the Vaquita

National Research Council Associate Barb Taylor's presentation at the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9, which she co-authored with Operations Research Analyst Tim Gerrodette, was on the use of statistical power as a management tool for detecting increases or decreases in abundance levels for threatened species such as the vaquita, *Phocoena sinus*. Taylor explained that the consequences of accepting a false null hypothesis can be acute in conservation biology because endangered populations leave little margin for error due to incorrect management decisions. She illustrated how she and Gerrodette had calculated and interpreted statistical power using an analysis of increases or decreases in abundance for the vaquita. A simulation of a line-transect survey using empirical data on distribution and group size and using sighting data from surveys of harbor porpoise, *Phocoena phocoena*, yielded the expected relationship of the coefficient of variation in abundance and of actual abundance of the harbor porpoise.

Both the power to detect a given decline and the minimum-detectable decline were calculated for populations of from 10 to 3,000 animals, using a varied number of surveys. Power to detect declines is very low for a population of less than 1,000. For example, even for a population of 1,000, Taylor and Gerrodette's analysis indicated that they could only correctly detect a decline 45% of the time, given 5 biennial surveys and a decline of 5% annually (a population reduction of 40% over the 10-year period).

Population estimates for vaquita have been in the range of 300 animals. For this estimate, even 10 annual aerial surveys have a minimum detectable decline of 18% per year (a reduction of 86%, or 42 animals). Thus, power analysis reveals that negative trends in abundance should not be required as a precondition for conservation action for this or any rare species. Taylor and Gerrodette have recently submitted their results to the *Journal of Conservation Biology*. (B. Taylor, FTS 893-7620)

## COASTAL MARINE MAMMAL PROGRAM

### Detecting Trends in Abundance of Harbor Porpoise in Central California

The Coastal Marine Mammal Program is currently monitoring trends in abundance of harbor porpoise, *Phocoena phocoena*, in central California. At the Ninth Biennial Conference on the Biology of Marine Mammals held in Chicago, Illinois, December 5-9, Biologist Karin Forney presented the results of the aerial line-transect surveys she and Operations Research Analyst Jay Barlow have been conducting over the last 5 years. They have been studying trends in abundance as a method of evaluating the status of populations when absolute abundances cannot be obtained. An analysis of covariance (ANCOVA) procedure was used to model porpoise abundance, measured as the number of porpoise seen per kilometer of search effort. Year was treated as a covariate, and other factors which influenced observed abundance were included as categorical variables.

Forney reported that no annual trend in harbor porpoise abundance has been detected during this 5-year series. However, simulations revealed that, despite the analysis of covariance (ANCOVA) model's good fit ($p < 0.0001$), power to detect trends in abundance accurately is very poor. This may be due to the large degree of variability in the data ($r^2 = .0492$), which is inherent in many field studies. Forney and Barlow's analysis showed that power can be improved by increasing $\alpha$ levels or by adding additional survey years.

In conclusion, although their analysis indicated no significant trend in harbor-porpoise abundance over the 5 years, it would be false to conclude that no trend occurred, because power to detect such a trend is poor using only 5 years of data. Based on these results, Forney and Barlow emphasized the necessity to evaluate power in statistical analysis (using simulations) before drawing conclusions that may have important management implications. (K. Forney, FTS 893-7171)

### Precision of Northern Elephant Seal and California Sea Lion Counts Obtained from Large-format Vertical Color Photographs

Fishery Biologist Mark Lowry presented a poster at the Ninth Biennial Conference on the Biology of Marine Mammals held at Chicago, Illinois, December 5-9, on the results of pinniped counts that he has been working on with Fishery Biologist Wayne Perryman. For the counts, they used large-format (127 mm and 228 mm) vertical aerial photographs to census northern elephant seals and California sea lions at the Channel Islands, and they conducted a coefficient of variation (cv) analysis of replicate counts of elephant seals using the 127 mm formate aerial color photographs. Their analysis indicates that pup counts are extremely precise with coefficients of variation ranging from 0.0064 to 0.0158. Replicate counts of California sea lion pups by individual interpreters corresponded closely for sand (cv = 0.0140) and for rock substrate (cv = 0.0277); however, counts by two interpreters, though corresponding closely for sand substrate (cv = 0.0195), did not correspond well for rock substrate (cv = 0.0905). Lowry and Perryman are currently analyzing other variables such as environmental conditions--cloud cover, tide height, and wind--that may also affect precision of California sea-lion pup counts. (M. Lowry, FTS 893-7174)

### Proposed Changes in the Way Marine Mammals Will Be Managed in the United States

Operations Research Analyst Jay Barlow presented a talk at the Ninth Biennial Conference on the Biology of Marine Mammals at Chicago, Illinois, December 5-9, which he co-authored with Wildlife Biologist Doug DeMaster. He discussed the proposed changes to the Marine Mammal Protection Act (MMPA) and some of the changes in the management of marine mammals since the enactment of the MMPA in 1972.

Barlow presented his and DeMaster's review of the National Marine Fisheries Service (NMFS) proposal which is currently out for public review. Under this method, stock-specific quotas would be established and the quotas would, in time, be based on a conservative fraction of a minimum estimate of population abundance. A different fraction would be allowed for cetaceans from that of pinnipeds, and various safety factors would be applied

for depleted and severely depleted populations. The new management procedures are designed to protect marine mammals without unnecessarily interferring with fisheries, live-capture, or research activities. Under the proposed rules, marine mammal populations would still be expected to equilibrate within their optimum-sustainable population (OSP) range. Copies of the proposed regulations can be obtained from either Herb Kaufman or Charles Karnella at the National Marine Fisheries Service Office of Protected Resources. (D. DeMaster, FTS 893-7165)

**Marine Mammal Assessment Survey for the Coastal Waters of California Completed**

On November 5, 1991, the National Oceanic and Atmospheric Administration (NOAA) research vessel *McArthur* entered the port in San Francisco, completing the fourth and final leg of the first California Marine Mammal Survey (CAMMS). The cruise was conducted in four legs, lasting between 19 and 24 days each, and most of the survey effort was conducted within 200 nautical miles of the California coast. All survey effort was conducted north of Mexican waters and south of the Oregon border. Figure 1 shows complete cruise tracks for the *McArthur*.

The overall objectives of the project were to estimate abundance and to understand distribution of dolphins and whales which are commonly found in California waters and incidentally killed in U.S. commercial-gillnetting operations. The survey was designed to collect data for estimating the density, size, and species composition of dolphin and whale aggregations in order to make mean and minimum estimates of their population sizes. Physical, biological, and oceanographic data regarding habitat of marine mammals were also collected in order to better understand marine mammal distributions. Individual identification photographs of blue, humpback, right, and sperm whales were taken to be used in estimating population sizes using mark-recapture methods.

Preliminary calculations indicate that 733 schools of cetaceans were sighted. Of the total schools sighted, 40% were seen on Leg 1, 25% on Leg 2, 22% on Leg 3, and 13% on Leg 4. Of the 5544 nautical miles of trackline surveyed, 36% was completed on Leg 1, 23% on Leg 2, 25% on Leg 3, and 16% on Leg 4. The differences in survey effort between legs are due to the weather patterns encountered during the cruise.

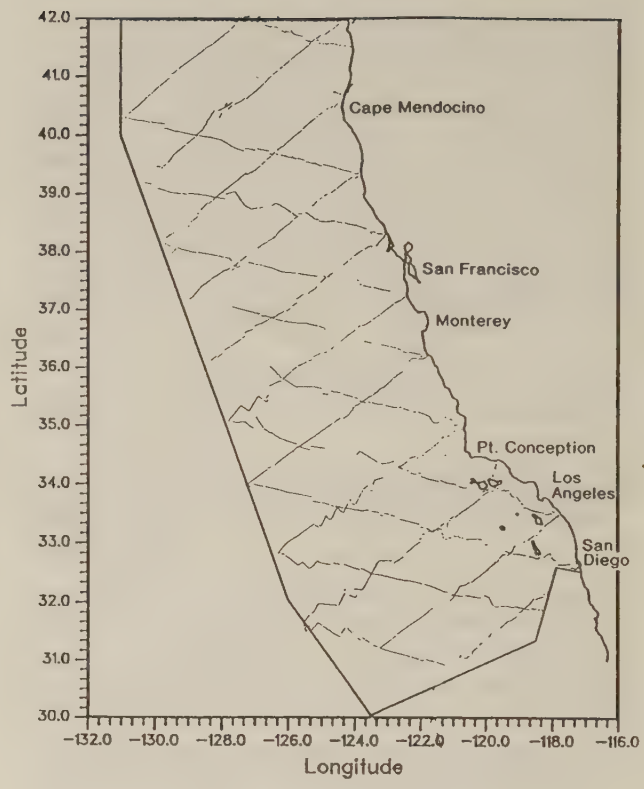


Figure 1. Tracklines completed by the NOAA research vessel *McArthur* during the 1991 California Marine Mammal Survey. (Tracklines show actual survey effort; breaks or diversions in tracklines were due to bad weather or sea conditions.)

Common dolphins were the most frequently encountered dolphin (156 sightings) and blue whales were the most frequently encountered large whale (64 sightings). Preliminary results of the data collected during the California Marine Mammal Survey (CAMMS) cruise are presented in the following tables: Preliminary results of cetacean sightings from NOAA ship *McArthur* during the 1991 California marine mammal survey (Table 1), Biopsy samples collected during the 1991 California marine mammal survey (Table 2), Numbers of environmental data samples collected during the 1991 California Marine Mammal Survey aboard the NOAA ship *McArthur* (Table 3), Sonobuoy recordings collected during the 1991 California Marine Mammal Survey aboard the NOAA ship Arthur (Table 4), and Number of photographs taken of large whale species during the 1991 California Marine Mammal Survey aboard the NOAA ship *McArthur* (Table 5). These data are currently being analyzed and will be used during an upcoming workshop discussing the status of cetacean stocks. Final reports will be distributed by July 1992. (J. Barlow, FTS 893-7178)

Table 1. Preliminary results of cetacean sightings from NOAA ship *McArthur* during the 1991 California marine mammal survey.

| | Leg 1 | Leg 2 | Leg 3 | Leg 4 | TOTAL |
|---|---|---|---|---|---|
| common dolphin (unid. stock) | 3 | 7 | 2 | 0 | 12 |
| striped dolphin | 3 | 6 | 10 | 6 | 25 |
| common dolphin (long-beaked) | 0 | 1 | 7 | 0 | 8 |
| common dolphin (short-beaked) | 55 | 42 | 39 | 20 | 156 |
| bottlenose dolphin | 0 | 1 | 13 | 2 | 16 |
| Risso's dolphin | 4 | 4 | 13 | 9 | 30 |
| Pacific white-sided dolphin | 8 | 4 | 2 | 4 | 18 |
| northern right whale dolphin | 1 | 7 | 10 | 2 | 20 |
| killer whale | 4 | 0 | 0 | 2 | 6 |
| harbor porpoise | 32 | 9 | 0 | 0 | 41 |
| Dall's porpoise | 99 | 20 | 0 | 7 | 126 |
| sperm whale | 4 | 3 | 7 | 0 | 14 |
| pygmy sperm whale | 0 | 0 | 0 | 3 | 3 |
| Cuvier's beaked whale | 2 | 1 | 4 | 7 | 14 |
| Baird's beaked whale | 3 | 0 | 0 | 0 | 3 |
| gray whale | 1 | 0 | 0 | 0 | 1 |
| rorqual whale | 8 | 0 | 5 | 0 | 13 |
| minke whale | 2 | 3 | 0 | 0 | 5 |
| Bryde's whale | 0 | 0 | 1 | 0 | 1 |
| fin whale | 5 | 17 | 5 | 3 | 30 |
| blue whale | 18 | 22 | 16 | 8 | 64 |
| humpback whale | 4 | 6 | 3 | 3 | 16 |
| Bryde's/Sei whale | 2 | 1 | 0 | 0 | 3 |
| unidentified dolphin | 8 | 9 | 6 | 5 | 28 |
| unidentified beaked whale | 0 | 1 | 2 | 4 | 7 |
| unidentified *Mesoplodon* spp. | 4 | 1 | 1 | 0 | 6 |
| unidentified small whale | 3 | 3 | 7 | 3 | 16 |
| unidentified large whale | 14 | 11 | 4 | 2 | 31 |
| unidentified whale | 0 | 0 | 1 | 0 | 1 |
| unidentified cetacean | 3 | 5 | 0 | 2 | 10 |
| unidentified object | 5 | 1 | 3 | 0 | 9 |

Table 2. Biopsy samples collected during the 1991 California marine mammal survey.

| Species sampled | Leg 1 | Leg 2 | Leg 3 | Leg 4 | Total |
|---|---|---|---|---|---|
| Northern right whale dolphin | 1 | 0 | 0 | 0 | 1 |
| Blue whale | 0 | 2 | 0 | 0 | 2 |
| Pacific white-sided dolphin | 1 | 0 | 0 | 1 | 2 |
| Common dolphin (short-beaked) | 0 | 4 | 4 | 14 | 22 |
| Common dolphin (long-beaked) | 0 | 0 | 1 | 0 | 1 |
| Total | 2 | 6 | 5 | 15 | 28 |

Table 3. Numbers of environmental data samples collected during the 1991 California Marine Mammal Survey aboard the NOAA ship *McArthur* XBT CTD Chlor-a Primary Productivity Turtle Sightings

| | XBT | CTD | Chlor-a | Primary Productivity | Turtle Sightings |
|---|---|---|---|---|---|
| LEG 1 | 36 | 22 | 212 | 196 | 0 |
| LEG 2 | 25 | 18 | 167 | 161 | 1 |
| LEG 3 | 26 | 20 | 197 | 175 | 0 |
| LEG 4 | 17 | 16 | 116 | 126 | 0 |
| Total | 104 | 76 | 692 | 658 | 1 |

Note: Continuous sea surface temperature and salinity measured during all 4 legs.

Table 4. Sonobuoy recordings collected during the 1991 California Marine Mammal Survey aboard the NOAA ship *McArthur.*

| Species recorded | Leg 1 | Leg 2 | Leg 3 | Leg 4 | Total |
|---|---|---|---|---|---|
| Common dolphin (short-beaked) | 0 | 0 | 0 | 1 | 1 |
| Killer whale | 1 | 0 | 0 | 1 | 2 |
| Total | 1 | 0 | 0 | 2 | 3 |

Table 5. Number of photographs taken of large whale species during the 1991 California Marine Mammal Survey aboard the NOAA ship *McArthur.*

| Species photographed | Leg 1 | Leg 2 | Leg 3 | Leg 4 | Total |
|---|---|---|---|---|---|
| Blue whale | 259 | 152 | 121 | 161 | 693 |
| Humpback whale | 96 | 34 | 4 | 28 | 162 |
| Fin whale | 3 | 2 | 0 | 0 | 5 |
| Killer whale | 20 | 0 | 0 | 0 | 20 |
| Total | 378 | 188 | 125 | 189 | 880 |

# HONOLULU LABORATORY

Honolulu, Hawaii

## PELAGIC RESOURCES INVESTIGATION

### Recaptures of Tagged Blue Marlin Indicate Long-distance Movements

Fishery biologists at the Honolulu and La Jolla Laboratories have begun to see a pattern in the movements of Pacific blue marlin, *Makaira mazara.* Recent recaptures of tagged blue marlin indicate

that they sometimes travel great distances on their way to and from the Hawaiian Islands.

Anglers in Hawaii have tagged and released over 600 Pacific blue marlin since 1980, by far the greatest number of blue marlin tagged anywhere in the Pacific. Of these, only about a dozen have been recaptured.

Tagging is coordinated by the Cooperative Marine Gamefish Tagging Program managed by Fishery Research Biologist James L. Squire, Jr. of the La Jolla Laboratory. Tags are supplied to Hawaii's anglers through the Honolulu Laboratory and the Hawaii International Billfish Association and to anglers fishing in other areas of the Pacific by the Southwest Fisheries Science Center, La Jolla, California. Fishermen are encouraged to tag and release billfish which, if recaptured, can provide data on fish movements.

Two recent long-range recaptures show long-distance movements from Hawaii to the South Pacific and from Mexico to Hawaii--journeys of over 2,500 miles. One is a 120 kg (265 lb) Pacific blue marlin that swam to Hawaii from Mexico and was caught by Dale Simmons off Waianae, Oahu, on December 7, 1991. This fish had been tagged and released 14 months earlier by Jim Clarke off Baja California. The second is a 50 kg (110 lb) Pacific blue marlin tagged by Robert O'Laughlin and Mike Holtz off Keahole Point, Hawaii, on August 5, 1991. It traveled to the South Pacific near the Marquesas Islands where it was caught 3 months later by Kikuji Ito, a longline fisherman.

Earlier recaptures of two other Pacific blue marlin also indicate long-distance movement across the equator and from east to west across the Pacific. One was released off Baja California, Mexico, in October 1989 and recaptured near the Marquesas Islands in February 1991. The other was tagged off Christmas Island in October 1985 and recaptured off New South Wales, Australia, in March 1986.

In contrast to these four long-distance recoveries, five Pacific blue marlin have been tagged and recaptured in Hawaii. These fish were released during the June-August fishing season. Four were recaptured during the same season in the year of release, and the fifth was recaptured in January of the following year. The seasonality of these tag returns and the low troll-catch rate of blue marlin in September-May suggest that many blue marlin leave Hawaii for part of the year and then return, perhaps traveling long distances in the interim. The few recaptures of Pacific blue marlin not mentioned have occurred off Mexico in the eastern Pacific after being tagged and released off Mexico.

Recreational anglers and the charterboat fleet, with the aid of these cooperators, are the backbone of the Cooperative Marine Gamefish Tagging Program, which tagged a total of 274 billfish in Hawaii in 1990. Longline and handline commercial fishermen have also helped by reporting recaptured fish, and recently, some longline fishermen began tagging and releasing fish. Captain Bobby LaRue of the longline fishing vessel *Gail Ann* tagged and released four swordfish, *Xiphias gladius*, in November 1991. Two bigeye tuna, *Thunnus albacares*, and one striped marlin, *Tetrapturus audax*, tagged and released from National Marine Fisheries Service search longline gear, have been recaptured in Hawaii.

Cooperative Marine Gamefish Program tags can be identified by the "LA JOLLA, CA" address printed on the tag. Fishermen who capture fish with these tags or who release fish that are later recaptured are rewarded with caps emblazoned with a leaping marlin. Several other kinds of tags, some of which offer a cash reward, may also be recovered around Hawaii. Tag recoveries can be reported to Squire or to Christofer H. Boggs, fishery biologist with the Honolulu Laboratory. (C. Boggs (808) 943-1222 and J. Squire, Jr. FTS 893-7072)

## INSULAR RESOURCES INVESTIGATION

### Eddies and Mesoscale Fronts Observed in the Northwestern Hawaiian Islands

Data from satellite drifter buoys and acoustic Doppler current profilers provide a picture of the oceanography in the northwestern Hawaiian Islands to complement the lobster larval studies by the Insular Resources Investigation. On March 1, 1991, four satellite drifter buoys, with drogues on 30-m lines, were deployed in the northwestern Hawaiian Islands--two at Necker Island and two at Maro Reef. Seven months later, all four buoys are still in the vicinity of the northwestern Hawaiian Islands, and their tracks indicate that eddy activity is a significant component in the nearshore oceanography. Interestingly, one buoy has remained in one or more eddies south of Necker Island for the entire 7-month period (Figures 1 and 2).

In October 1991, a cruise collected acoustic Doppler current profiler data along 178°E from 21° to 28°N, an area well to the east of the Hawaiian Ridge

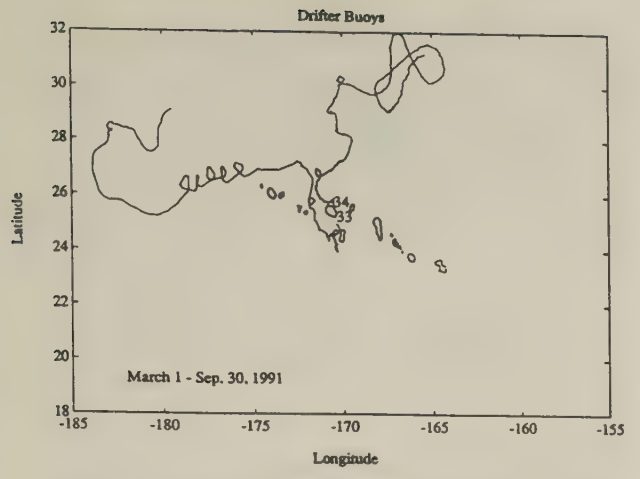


Figure 1. Movement of two drifter buoys (N0. 33 and 34) released at Maro Reef in the northwestern Hawaiian Islands.

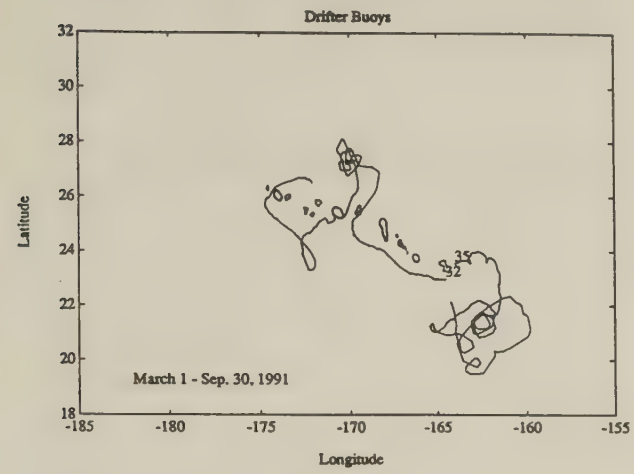


Figure 2. Movement of two drifter buoys (No. 32 and 35) released at Necker Island in the northwestern Hawaiian Islands.

and away from any influence the ridge topography might have on water movement. Data on the currents show alternating bands, 30 to 120 nmi wide, of east and west flow (10-20 cm/sec) (Figure 3). Data from cruises along the ridge in March and October 1991 also show this banded structure (Figure 4). Gunnar Roden of the University of Washington has previously described this banded east and west flow in the central and eastern Pacific, based on conductivity/temperature/depth data, and has interpreted the structure to represent mesoscale fronts. With the data recently collected from lobster larval-sampling cruises, it will be possible to investigate whether these fronts are important for lobster larval survival and retention. (J. Polovina, (808) 943-1218)

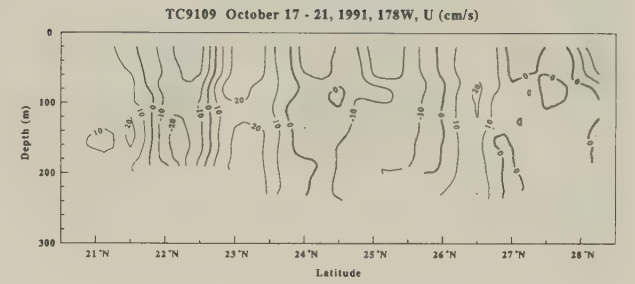


Figure 3. Acoustic Doppler current profiler data, collected to the west of the Hawaiian Ridge along 178°E from 21° to 28°N, showing alternating bands of east (uns haded) and west (shaded) flow.

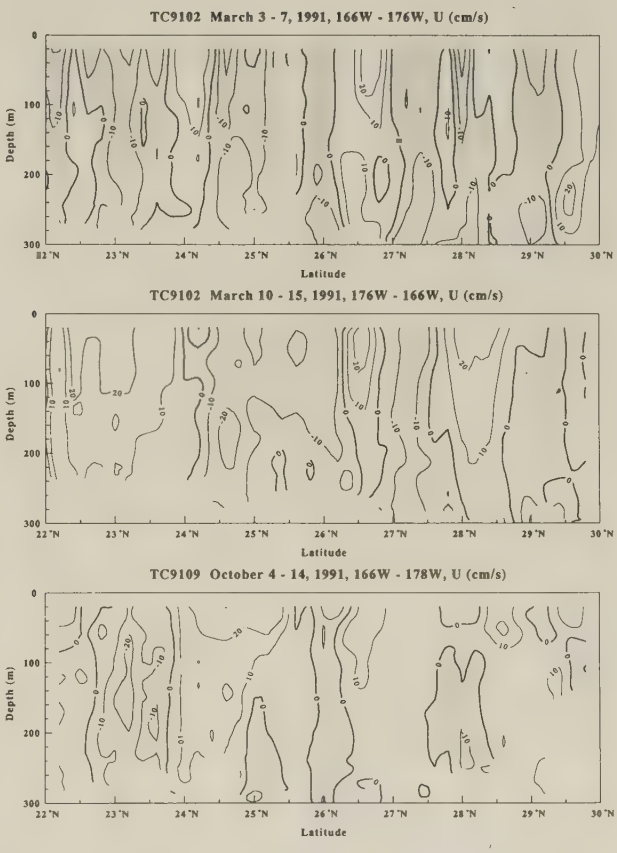
TC9102 March 3 - 7, 1991, 166W - 176W, U (cm/s)
TC9102 March 10 - 15, 1991, 176W - 166W, U (cm/s)
TC9109 October 4 - 14, 1991, 166W - 178W, U (cm/s)
Depth (m)
Latitude

Figure 4. Acoustic Doppler current profiler data collected in March and October 1991 along the Hawaiian Ridge showing the same pattern of alternating east (unshaded) and west (shaded) flow as in Figure 3.

### Subsurface Fish Handling Limits Decompression Effects on Deepwater Species

Fishery Biologists Frank A. Parrish and Robert B. Moffitt recently completed a manuscript on the development of a methodology necessary to acoustically track juvenile Hawaiian pink snapper, Pristipomoides filamentosus: "Subsurface Fish Handling to Limit Decompression Effects on Deepwater Species."

Their method of handling hooked fish at intermediate depth was developed for species that occur deeper than conventional scuba depths. Juvenile P. filamentosus were hauled from 65-100 m to a depth of only 30 m, where the ambient pressure change was a fraction of that produced by hauling fish to the sea surface. This method afforded a unique opportunity to acoustically tag deepwater physoclistous fish without the need to significantly alter the fish's original swim bladder volume, thereby reducing the risk of affecting the fish's subsequent behavior. Surface handling of the fish for release, including venting the swim bladder with a syringe and repositioning the stomach when everted, has resulted in only about 40-50% survival at the surface and an unknown additional mortality after release.

The P. filamentosus tagged in Parrish and Moffitt's study survived, behaved well, and were tracked successfully. Behavior exhibited in each fish's 5-day track was consistent and suggested a highly localized home range (500 m2). Two areas within the home range were identified, a day site at the deeper extreme of the home range and a night site at the shallow end (Figure 5). The distance between the two sites was roughly 200 m. Camera drops on each of the two sites revealed a low-relief silt bottom with invertebrate burrows as the only feature.

The consistently tight localization and systematic crepuscular movement over seemingly featureless substrate suggest that the fish were uninjured and were not overly stressed during the tagging operations.

Parrish and Moffitt state that their subsurface handling method could be applied to a variety of deepwater species in a number of research approaches, including tagging and dietary studies. (F. Parrish, (808) 943-1254)

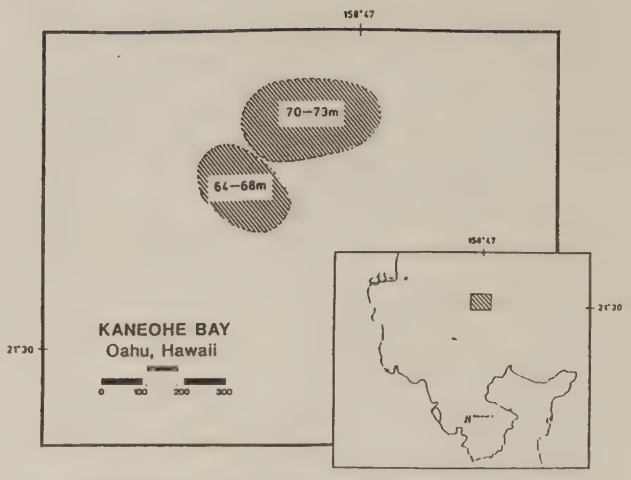


Figure 5. Two areas identified within the home range of a *P. filamentosus* tracked over a 5-day period in Kaneohe Bay, Oahu: a day site at the deeper (70-73 m) extreme of the home range and a night site at the shallow (64-68 m) end.

## FISHERY MANAGEMENT AND PERFORMANCE INVESTIGATION

### Mid-year 1991 Fishery Landings Summarized

Kurt E. Kawamoto, fishery biologist, has completed summaries of Hawaii's wholesale market-monitoring data for the first 6 months of 1991. Comparison with 1990 results, based on a sampling rather than expanded estimates of landings, revealed a number of marked changes during 1991. Longline landings of pelagic fishes increased by approximately 60% whereas troll and handline landings decreased by 14%, with substantial declines in bigeye tuna, *Thunnus obesus*, and yellowfin tuna, *T. albacares*, and substantial increases in ono (wahoo), *Acanthocybium solandri*. Bottomfish landings from the northwestern Hawaiian Islands increased by 11% (with an 87% increase in landings of red snapper, *Etelis coruscans*), but those from the main Hawaiian Islands decreased by 28%. The data were not "corrected" for changes in sampling intensity or site prevalence. In light of reduced monitoring resources, the Fishery Management and Performance Investigation is preparing a proposal to limit auction monitoring to systematic sampling once weekly beginning in 1992, rather than the present 5 days per week. (S. Pooley, (808) 943-1216)

### Third Quarter 1991 Longline-logbook Summaries Completed

Robert A. Dollar, biological technician, reports that the third quarter 1991 longline-logbook sum-

maries have been completed. Dollar states that the number of permitted longline vessels in Hawaii with limited-entry permits increased slightly from 141 vessels during the first two quarters (January-June) of 1991 to 153 vessels for the last quarter of 1991. Data received from Federal logbooks and submitted to the Honolulu Laboratory by Hawaii longline vessel captains thus far show that 332 trips were taken by 111 longline vessels during the third quarter (July-September) of 1991. This was a substantial decrease from the 546 trips made by 127 vessels during the second quarter (April-June) of 1991.

Total effort in the third quarter of 1991 was 2.1 million hooks set compared to 3.6 million hooks in the second quarter. Effort outside the Hawaiin 200-mile Exclusive Economic Zone declined from 1.3 million hooks in the second quarter to 959,000 hooks in the third quarter. Effort in the main Hawaiian Islands decreased to 932,000 hooks, down from 1.8 million hooks in the second quarter.

Audits of longline logbooks by staff of the Fishery Management and Performance Investigation indicate that, of the 113 longline trips in August and September 1991, 78% recorded "good" data while the remaining 22% had "poor" data. "Poor" data were determined as substantial deviation between the number of individual species logged as "kept" and the number recorded during off-loading. Nonetheless, this is an improvement over the previous two quarters in which over 57% of the logbook data were poor or questionable.

The size of the longline-area closures around the main Hawaiian Islands was reconsidered at a meeting of the Western Pacific Regional Fishery Management Council in Honolulu on December 16-19, 1991. The current proposal, contained in an amendment to the Pelagic Fishery Management Plan (FMP) under review in Washington, D.C., is to continue the existing emergency closure of 75 miles around the islands of Kauai and Oahu and 50 miles around the islands of Maui, Molokai, and Hawaii. The primary purpose of the closures is to avoid gear conflicts between the larger longline vessels and the smaller troll and handline vessels.

The council considered a motion to reduce the 75-mile limit to 50 miles and to implement a seasonal opening to 25 miles on the windward coasts of each island (except Oahu) during October-April, but the motion was rejected after considerable discussion.

The emergency regulations on longline-fishing closures expired December 16, allowing longline fishing throughout the main Hawaiian Islands until the Pelagic Fishery Management Program amendment takes effect. The final regulations, if approved, will not take effect until mid-January 1992 at the earliest. (S. Pooley, (808) 943-1216)

## WESTERN PACIFIC FISHERY INFORMATION NETWORK

### Fisheries Data Coordinating Committee Meets

On December 16, 1991, the 16th meeting of the Fisheries Data Coordinating Committee (FDCC) of the Western Pacific Fishery Information Network (WPACFIN) was held at the Pagoda Hotel in Honolulu, Hawaii. The FDCC is composed of the directors of the WPACFIN-participating island fisheries offices in American Samoa, Hawaii, Guam, and the Northern Mariana Islands as well as representatives from the Honolulu Laboratory, the Southwest Region Pacific Area Office, and the Western Pacific Regional Fishery Management Council. The FDCC provides guidance and coordination for the implementation and operation of the fishery information network in the western Pacific.

The primary purpose of the 16th meeting was to agree upon new target funding levels for each agency based on the recently announced $490,000 PACFIN allocation for the western Pacific. The FDCC discussed making various modifications to each agency's original proposals which were submitted in October, improving the proposals, and having them reflect the approved budget amounts. The proposals will be modified and resubmitted by mid-January. These funds will be used to help island agencies support federal fisheries management needs for data, information, analysis, and reports. (D. Hamm, (808) 943-1214)

# PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

## ROCKFISH RESEARCH IN MONTEREY BAY

### Recreational Fisheries Analyzed

Fishery Biologists Jan Mason and Richard Parrish have been analyzing multi-decadal trends in species composition of rockfishes taken in Monterey Bay recreational fisheries. Mason and Parrish found that Monterey Bay has been a center

for recreational fisheries during the last century and that catch and effort data have been recorded for the area for about 40 years. Extensive creel surveys were conducted by D. Miller, M. Odemar, D. Gotshall, and J. Geibel of the California Department of Fish and Game (CDFG) during the 1960's and early 1970's. From these surveys, Mason and Parrish concluded that blue rockfish, Sebastes mystinus, was the most abundant species in partyboat and skiff catches but that size and numbers of blue rockfish fluctuated in both fisheries during these years and that more small blue rockfish were caught by skiff anglers than partyboat anglers.

Species and size compositions of rockfishes from these early surveys were compared with similar data collected from 1977 to 1986 by fishery biologists from the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS) as part of the California Cooperative Rockfish Survey and the Marine Recreational Fish Statistical Survey (MRFSS). A longer time series allowed Mason and Parrish to assess changes during much of the history of the recreational fisheries in Monterey Bay. In their preliminary analyses, data are grouped into five time periods (1959-61, 1966, 1977-80, 1981-83, 1984-86). Further MRFSS data will be available in the spring of 1992.

By combining all species of rockfishes in these time periods, however, Mason and Parrish found that size distribution of fishes from the skiff fishery was concentrated between 20 and 40 cm total length (TL) and that less than 10% of the rockfishes in this fishery were greater than 40 cm (Figure 1). Twenty to thirty percent of all rockfishes collected in the partyboat fishery were greater than 40 cm TL.

The size distributions of rockfishes from partyboat catches in 1960-61 and 1984-86 are similar. However, size distributions from intervening years varied greatly. Rockfishes generally were smaller, with fewer fishes over 40 cm, in catches from 1966. During 1977-80 and 1981-83, the percentages of rockfishes over 40 cm and 50 cm were higher than in either earlier or later time periods.

Size distribution of rockfishes in the skiff fishery was quite different. Rockfishes were smaller in 1966 in both skiff and partyboat catches, but smaller fishes continued to dominate the skiff catches during 1979-80. Fishes over 30 cm did not increase in numbers until 1981-83, and

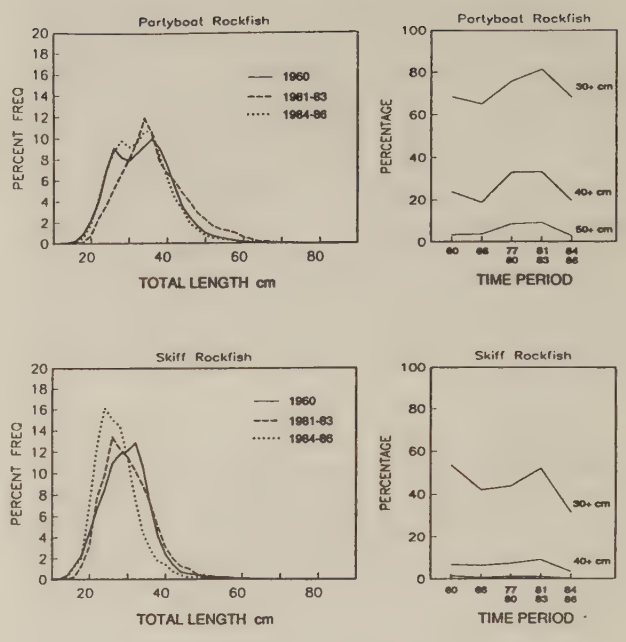


Figure 1. Total length of all species of rockfish from partyboat and skiff fisheries from listed time periods and percentages of rockfish larger than given sizes.

even then, this size group did not exceed its contribution of 1959. Thus, there was an increase in the proportion of small rockfishes in catches from the skiff fishery during the latest period (1984-86), compared to the four earlier periods.

Species composition varied between skiff and partyboat fisheries (Table 1). Non-rockfish species were more abundant in the skiff fishery. White croaker, Genyonemus lineatus, and Pacific sanddab, Citharichthys sordidus, represented from 10 to 33% of the total catch in the skiff fishery. However, these species were not significant components of the partyboat catch. Boccacio, S.paucispinis, and chilipepper, S. goodei, rockfishes increased in abundance and rank order of importance in the partyboat fishery throughout the time of analysis, while numbers of blue rockfishes declined. Boccacio and chilipepper rockfishes occur in deeper water than do blue rockfish and yellowtail rockfish; their increased abundance reflects a change in areas fished by partyboats in later years, both in water depth and distance from port. Numbers of boccacio and chilipepper rockfishes remained low in the shallow water-skiff fishery.

Mason and Parrish state that changes in fishing areas and species composition of partyboat catches

Table 1. Dominant species (% of total catch) of fishes captured in skiff and partyboat fisheries in Monterey Bay, California.

| | 1959 -60 | 1966 | 77- 80 | 81- 83 | 84- 86 |
|---|---|---|---|---|---|
| PARTYBOAT | | | | | |
| blue rockfish | 41 | 28 | 21 | 28 | 12 |
| yellowtail rockfish | 23 | 22 | 12 | 16 | 11 |
| olive rockfish | 3 | 7 | 7 | 7 | 2 |
| chilipepper rockfish | 1 | 3 | 17 | 10 | 20 |
| boccacio rockfish | 3 | 6 | 9 | 10 | 10 |
| SKIFF | | | | | |
| white croaker | 18 | 20 | 18 | 6 | 10 |
| Pacific sanddab | 15 | 12 | 11 | 4 | 8 |
| blue rockfish | 31 | 10 | 15 | 26 | 15 |
| yellowtail rockfish | 3 | 5 | 5 | 6 | 4 |
| olive rockfish | 3 | 1 | 2 | 6 | 3 |
| brown rockfish | 2 | 10 | 3 | 7 | 11 |
| canary rockfish | 3 | 4 | 6 | 4 | 3 |
| gopher rockfish | 3 | 3 | 7 | 3 | 10 |
| copper rockfish | 3 | 5 | 3 | 3 | 2 |
| chilipepper rockfish | 0 | 1 | 0 | 0 | 0 |
| boccacio rockfish | 0 | 3 | 2 | 0 | 3 |

make trends in length-frequency data more difficult to analyze. But from the analyses already completed, they plan to address reasons for differences in size composition of rockfishes caught by the partyboat and skiff fisheries. Overall size of rockfishes and the availability of blue rockfish has declined in the skiff fishery, which is limited to a few miles from shore because of boat and motor sizes. However, temporary increases and no overall decline in rockfish sizes have occurred in the partyboat fishery. The analyses will focus on whether the partyboat fishery has shifted to deeper water and greater distances from port to assure the catch of larger rockfishes. (J. Mason, (408) 646-3290).

### Importance of Small-scale Refugia to Deepwater Rockfishes in Monterey Bay

As local stocks become depleted in shallow, accessible areas of Monterey Bay, deepwater rocky reefs may prove to be important rockfish habitat. Indeed, while making north-south transects across the eastern slope of Soquel Canyon at 200-260 m during two dives in the submersible *Delta*, J. Wourms and Fishery Biologist Mary Yoklavich, using a grant funded to Wourms and Clemson University by the National Oceanic and Atmospheric Administration (NOAA) National Undersea Research Program, reported high densities of large mature rockfishes--cowcod, *S. levis*, and tentatively yelloweye, *S. ruberrimus*, and vermillion, *S. miniatus*--and lingcod, *Ophiodon elongatus*, associated with an isolated outcropping of rocky substratum. Large aggregations of bocaccio rockfish occurred over the top of the outcrop at 200 m. These species were associated almost exclusively with this habitat, which was spatially small compared to surrounding soft mud. Because of the Monterey and Soquel Canyons, deepwater rocky habitat is accessible nearshore and relatively close to shallow heavily fished reefs, making comparisons feasible between these areas. Using in situ submersible techniques, Wourms and Yoklavich plan to document abundance and habitat associations of marine fishes that are closely associated with deepwater rocky areas. They have proposed a coordinated study conducted by fisheries biologists from Pacific Fisheries Environmental Group (PFEG), Moss Landing Marine Laboratories (MLML), the California Department of Fish and Game, and the Marine Science Institute at the University of California, Santa Barbara, and by geologists from MLML and the U.S. Geological Survey. Their proposed project currently has been approved by the West Coast National Undersea Research Center and is pending funds from the National Undersea Research Program.

From a high resolution geologic characterization of their study site in Soquel Canyon, Wourms and Yoklavich plan to map and quantify the amount of exposed hard substrata available at depths suitable to rockfishes. They will survey sites selected at random from a mosaic of side-scan sonographs and determine the extent and type of habitat that supports populations of adult rockfishes. From our fishery-independent estimates of rockfish abundance and size (i.e., apart from recreational and commercial catch records), they can evaluate the significance of small-scale refugia to rockfish populations that have been harvested in more accessible and more shallow habitats (M. Yoklavich, (408) 646-3336).

## IDEALIZED CIRCULATION PATTERNS IN THE MONTEREY BAY AREA

### Time and Space Circulation Patterns in Monterey Bay and the Adjacent Ocean Studied

In the near-future, the National Oceanic and Atmospheric Administration (NOAA) will officially designate Monterey Bay as a National Marine Sanctuary along the central California coast. The rationale for establishing a sanctuary in this area includes enhancing the protection of marine resources, monitoring these resources, and supporting

and promoting scientific research. A key to fulfilling these objectives is detailing and understanding the highly variable time-and-space circulation patterns in Monterey Bay and the adjacent ocean.

Unfortunately, previous field studies of the area's currents have been limited in scope. Because of logistical constraints, flow studies traditionally have been confined to short-term drifter and dye-patch tracking, indirect calculations from hydrographic surveys, and satellite coverage. More recently, longer-term current meter moorings have been deployed. However, their records represent the flow at only one site within what appears to be a highly complex spatial circulation. No single field study has been sufficient to explain the four-dimensional structure of Monterey Bay's circulation. Taken as a whole, however, this historical data base is an extremely valuable resource from which scientists may be able to develop a conceptual flow model for the bay and coastal ocean and form hypotheses to be tested systematically during field studies.

The two flow-pattern maps shown below are based on a summary of numerous field studies by Oceanographer Jerrold G. Norton's Pacific Fisheries Environmental Group's (PFEG) 1979 Summary of California Cooperative Oceanic Fisheries Investigation (CalCOFI) and Other Field Studies, which has been recently updated by Norton and Oceanographer Franklin B. Schwing (of PFEG) with information from additional studies, including information from the Southwest Fisheries Science Center (SWFSC) juvenile rockfish surveys. The purpose of these maps is two-fold. First, they provide managers in the National Oceanic and Atmospheric Administration (NOAA) National Marine Sanctuary Office an overview of the area's circulation, to aid in the formulation of policy regarding the new Sanctuary--such as the position of its boundaries and the regulation of activities within its confines. Second, they establish a conceptual model, a "strawman" of the bay's flow, from which local scientists can develop physical and biological field studies to test hypotheses.

These figures represent the general surface and deep (about 150m and greater) flow in the Monterey Bay area during the upwelling season (spring-summer) when wind forcing is predominantly from the north, and in the fall-winter when at times the wind forcing is from the south. The maps are based on numerous historical field surveys involving moored current meters, drifters, dye studies, geostrophic flow measurements, analysis of satellite imagery and ship surveys, and anecdotal

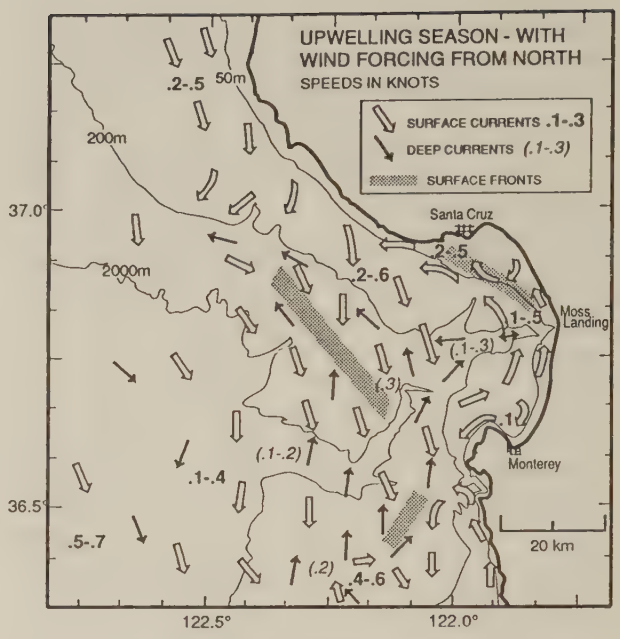


Figure 1. General surface and deep (about 150m and greater) flow in the Monterey Bay area during the spring-summer upwelling season. Wind forcing is predominately from the north.

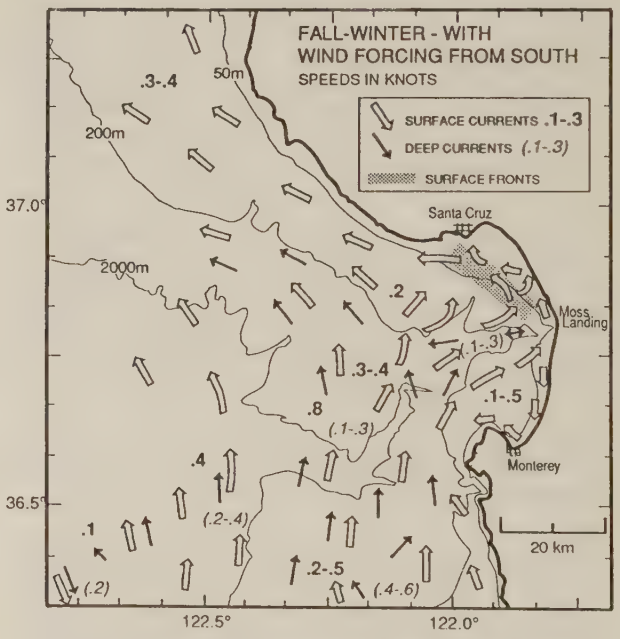


Figure 2. General surface and deep (about 150m and greater) flow in the Monterey Bay area during the fall-winter upwelling season. Wind forcing is predominantly from the south.

evidence. White arrows represent typical surface current directions; black arrows represent deep flow. Representative current speeds, in knots, are shown for different areas (0.2 knots equals about 10 cm/second). Bold numbers denote surface current

speeds; numbers in parentheses represent deep speeds. The general position of persistent surface fronts is shown as hatched areas.

These maps have been developed to give some idea of the currents that might exist under different wind patterns when they occur during the upwelling and winter-fall seasons. They do not necessarily reflect the exact current field at any one time, nor do they define the only flow pattern that occurs in each season. Because they are integrated from the results of numerous studies, the maps connote a more spatially coherent flow than may be expected at one instant. They also represent the current speed and direction that might typically exist at representative locations, when averaged over a suitably long time period (i.e., several days). The range and variance in the instantaneous flow at any site is likely to be much greater than the values shown in these figures.

Norton and Schwing believe that the deep flow is fairly steady over the course of several months, shifting between the two modes on a seasonal time scale. However, the surface flow switches on the scale of wind reversals (2-14 days). Thus, there are actually a minimum of four patterns: (1) upwelling (strong northerly), (2) relaxation (weak northerly or southerly) in the spring-summer, (3) southerly, and (4) northerly during fall-winter. Finally, it must be acknowledged that the deep flow also displays some synoptic scale variability on occasion and that, while circulation features are generally tied to bathymetric features, they also move horizontally and vertically to some degree.

Reversals in the direction of wind forcing occur throughout the year at periods of 2-14 days; thus, both flow patterns, and a continuum of intermediate states, may be expected in both the upwelling and fall-winter patterns. In addition, tidal and other higher-frequency effects, which are not included here, will further complicate or even dominate the instantaneous current field.

Norton and Schwing stress that these maps are idealized conceptual models from which scientists and managers can evolve ideas and research plans. Rather than a complete summary of historical observations, they are the beginning of what hopefully will be a coherent, long-term series of investigations whose goals are to systematically describe and understand the primary physical processes responsible for flow variability in the Monterey Bay area. Eventually, these studies can be extended to develop more general theories about circulation in coastal upwelling systems, in bays, and over submarine canyons. (Jerrold G. Norton, Franklin B. Schwing; (408) 646-3311)

# PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

## STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

### Scientist Participated in Successful Tracking of Striped Marlin off Kona, Hawaii

Fishery Biologist Dave Holts participated in the striped-marlin-behavior cruise aboard the National Oceanic and Atmospheric Administration (NOAA) ship *Townsend Cromwell* in the waters off Hawaii during November and December (see report from the Honolulu Laboratory). The cruise was designed to investigate striped-marlin behavior in relation to both water temperature and water currents. Six striped marlin were tagged with ultrasonic transmitters and tracked for 8 to 53 hours. Vertical depth profiles and horizontal-activity patterns of each fish were monitored along with depth profiles of both water temperatures and currents. This is the first marlin-tracking experiment that included time-current measurements from the ship's Doppler current-measuring system for analysis with the behavioral information.

The La Jolla staff plans to duplicate the Kona experiment off Cabo San Lucas, Baja, Sur, Mexico. Working with Dr. Arturo Muhlia of the Center for Biological Investigations, La Paz, Mexico, Holts and Fishery Biologist Norm Bartoo hope to tag and track six to eight striped marlin in an area of high-marlin abundance off Cabo San Lucas. The experiment is planned for February 1992 and preparations are underway. (Dave Holts, FTS 893-7186)

## MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

### Seychelles Purse-seine Data Updated

Gary Rensink, Biological Technician, has completed updating the second quarter, 1991 Seychelles Fishing Authority data from tuna purse seiners fishing in the western Indian Ocean. Data are summarized in LOTUS spreadsheets.

According to reports from the Seychelles Fishing Authority, the number of vessels participating in

the fishery in the western Indian Ocean during the second quarter of 1991 averaged 41 purse seiners (15 French, 17 Spanish, 3 Mauritian, 1 Panamanian, 3 Japanese, and 1 each from St. Vincent and the Seychelles), a significant decline when compared to the average of 48 vessels recorded for the same period the previous year.

The second-quarter catch rates in 1991 averaged 16 metric tons(t)/ day (6 t/day yellowfin and 9 t/day skipjack), significantly higher than the 14 t/day recorded for the same period in 1990 (Figure

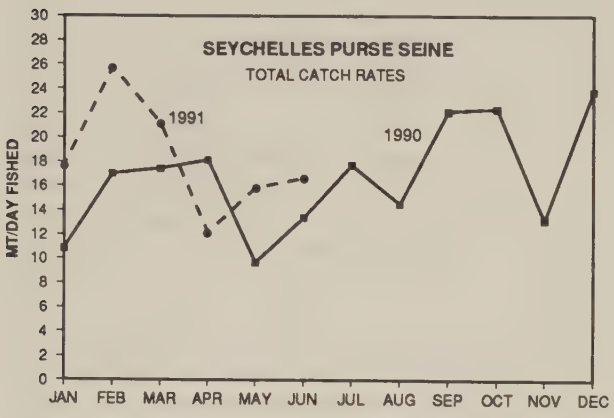


Figure 1. Catch rates (metric tons/day fished) for purse seiners fishing in the western Indian Ocean, 1990 and 1991.

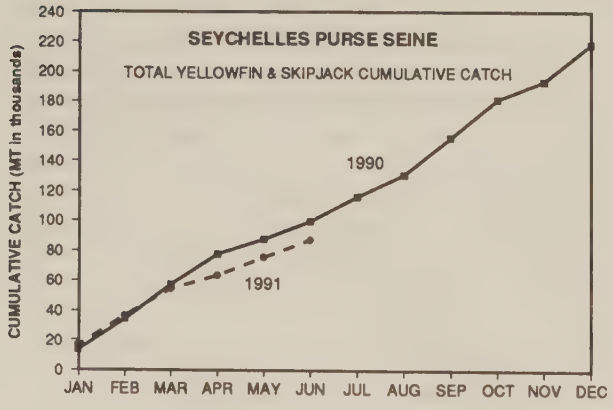


Figure 2. Cumulative catches (thousands of metric tons) of yellowfin and skipjack tuna combined, by purse seiners in the western Indian Ocean, 1990 and 1991.

1). Catch rates for the second quarter of 1991 were up 8% for yellowfin and up 9% for skipjack from those of the same period in 1990.

Total catch, combining yellowfin and skipjack tuna, during the second quarter of 1991 was 32,690 t, down 23% from that of the same period in 1990. The cumulative catch for 1991, up to June, totaled 87,317 t, 13% lower than that recorded for the same period in 1990 (Figure 2). This lower total was due primarily to fewer vessels operating in 1991, resulting in a 30% decline in fishing effort.

The species composition of the catch for the second quarter of 1991 was 38% yellowfin, 56% skipjack, and 6% other tuna, compared to 39% yellowfin, 60% skipjack, and 1% other tuna during the same period in 1990. (Gary Rensink, FTS 893-7192)

## First FAO Expert Consultation on Interactions of Pacific Tuna Fisheries

Fishery Biologist Norman Bartoo, Mathematician Al Coan, and Operations Research Analyst Carlos Salvadó attended the FAO- sponsored Expert Consultation of Pacific Tuna Fisheries in Noumea, New Caledonia, on December 3-11, 1991. The first session involved presentations and discussions on methods for identifying interactions between Pacific tuna fisheries. Subsequent sessions dealt with reviews of various tuna fisheries of concern: Pacific skipjack, eastern and western Pacific yellowfin, North and South Pacific albacore, Pacific bigeye, northern and southern bluefin tuna, and Pacific small tunas.

The participants concluded that potentials for interactions between fisheries were fairly easy to identify but that hard evidence for interactions was lacking in many cases. One example is the distant-water purse-seine fishery for yellowfin tuna in the western Pacific interacting with the domestic commercial and artisanal fisheries of islanders. The fisheries operate in the same areas and during the same seasons. However, comparisons of catch rates do not demonstrate a conclusive interaction. Because tagging of yellowfin in the area is fairly new, tagging data are not available. Fisheries for which there is extensive evidence of interactions are northern and southern bluefin tunas, skipjack, and albacore. This evidence comes from extensive tagging experiments on these species or, in the case of albacore, thorough net-marking of fish that escape from gillnets and later are caught by troll gear.

The participants also concluded that quantifying the extent of confirmed interactions is difficult for most fisheries. Untested models have been

developed, but they are either specific to a particular fishery or have not yet been applied.

Recommendations were offered by the participants. Most common were calls for improved fishery and tagging statistics and development of tag-analysis models. A report with results of the consultation including a list of recommendations is in preparation for release by June 1992. (A. Coan, FTS 832-7079)

### Atlantic Ocean-catch Statistics Updated

Donna Da Rodda, computer programmer, has completed updating the Southwest Fisheries Science Center's (SWFSC) Atlantic tuna-catch data base. The data base now contains data for the period 1950 to 1989, or the latest data available from the International Commission for the Conservation of Atlantic Tunas (ICCAT). Catches are for tuna and tuna-like species caught by countries using a variety of gears in the Atlantic Ocean. The data base is stored in a commercial data-base package, FOX-BASE, and can also be accessed through DBASE.

The data base can be used to generate catch trends by querying the data base in DBASE and plotting the results in LOTUS. Examples are shown here for the major tropical and temperate-tuna species. Total Atlantic catches of yellowfin tuna increased to a high of 160,412 metric tons (t) in 1983, skipjack tuna to a high of 153,035 t in 1982, and bigeye tuna to a high of 74,277 t in 1985. Both bigeye and yellowfin tuna catches increased in 1989 over those in 1988, whereas skipjack catches decreased (Figure 3). Bluefin tuna catches decreased from a high of 37,047 t in 1955 to lows of 14,492 t in 1972 and 14,532 t in 1973, and they have fluctuated be-

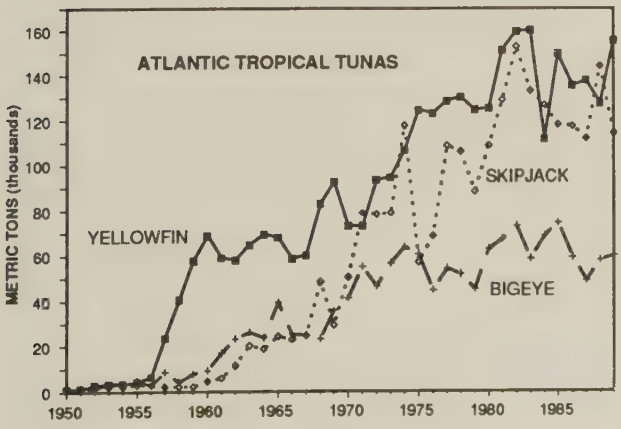


Figure 3. Atlantic yellowfin, skipjack, and bigeye catches (1000 metric tons (t) for the period 1950-89.

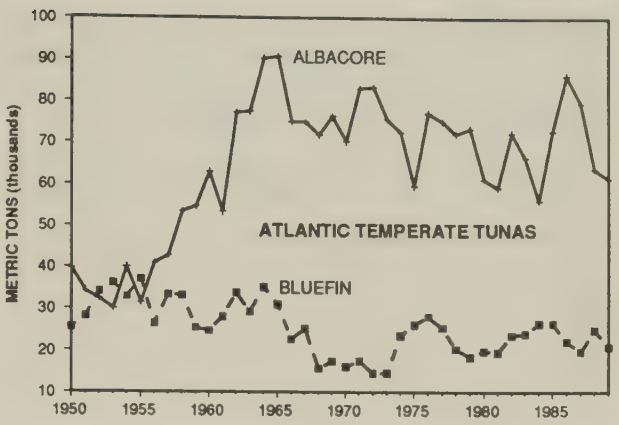


Figure 4. Atlantic bluefin and albacore catches (1000 metric tons (t) for the period 1950-89.

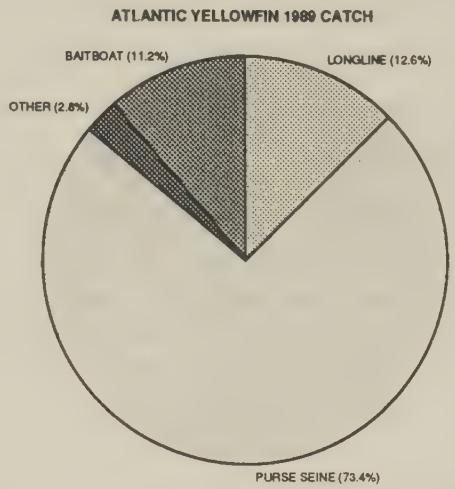


Figure 5. Gear composition of the Atlantic yellowfin catch in 1989.

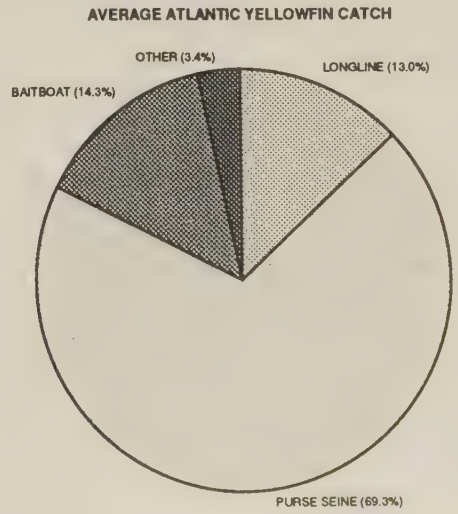


Figure 6. Average gear composition of the Atlantic yellowfin catch for the period 1984-88.

tween 18,000 and 29,000 t since then. Albacore catches rose to 90,353 t in 1964 and 90,732 t in 1965, and in recent years, to 86,247 t in 1986; however, they dropped to 61,411 t in 1989 (Figure 4).

The data base can also be used to assess proportion of catches by gear or country. An example of yellowfin tuna catches by gear shows that the largest portion of the 1989 catch was taken by purse seiners (Figure 5). This is an increase of 4% from the average proportion taken by purse seiners during 1984 to 1988 (Figure 6). (Donna DaRodda, FTS 893-7183)

# TIBURON LABORATORY

Tiburon, California

## GROUNDFISH COMMUNITIES INVESTIGATION

### Plans Developed For Sampling Lingcod Coastwide

It has become evident that the Allowable Biological Catch (ABC) for lingcod, *Ophiodon elongatus*, established by the Groundfish Management Plan in 1982, may need to be adjusted to reflect the current state of the fishery. To provide information on which to base this management decision, the commercial catch will be sampled coastwide beginning in January 1992. Fishery Biologists Peter Adams and Kelly Silberberg of the Groundfish Communities Investigation are coordinating the sampling of catches in California and Oregon while biologists for the state of Washington are continuing to sample the catch in that area as part of a program underway since 1982. It is also anticipated that the program will benefit from the age-validation project that has been in progress at the Tiburon Laboratory for several years.

The fishery involves two elements: lingcod taken by trips directed specifically at that species and lingcod taken as a bycatch by trips aimed primarily at other species. The directed fishery includes only about 30% of the trips that land lingcod, but the species represents a high percentage of the catch. The bycatch fishery, on the other hand, includes about 70% of the trips that land lingcod, but the species represents only a small percentage of the catch. It is important to distinguish between these two elements of the fishery because they may fish different segments of the population. The problem is increased by the greater probability of sampling the bycatch fishery since it involves so many more of the trips that take lingcod. To distinguish between the two types of landings, the record will include multiple clusters from each trip and a measure of within-trip variance. (Peter Adams and Kelly Silberberg, FTS 556-0565)

## GROUNDFISH ANALYSIS INVESTIGATION

### Cobb Seamount Yields a Wealth of Puzzles for Biologists

The Cobb Seamount is located approximately 300 miles off the southern Washington coast and has a minimum depth of 18 fathoms. The substrate is rocky and irregular. In September 1991, several vessels from Astoria, Oregon, began fishing on this isolated seamount. Because the seamount is beyond the Exclusive Economic Zone (EEZ), fishermen are not subject to trip limits which exist on species within the EEZ. Several landings in excess of 100,000 lbs of widow rockfish, *Sebastes entomelas*) have been made. Don Pearson and Bill Barss of the Oregon Department of Fish and Wildlife, Newport, Oregon, performed a preliminary examination of several samples taken from the fishery. A total of 327 fish was aged, and maturity state was recorded. Several surprising features were observed in the fish from the seamount. Less than 1% of the fish were older than 6 years, and many were only 3 years old, which is much different from catches made within the EEZ where fish less than 5 years old are not common. Mean length at age for the Cobb Seamount fish was comparable to the mean length at age for fish on the northern Oregon coast; however, the mean age at sexual maturity appears to occur earlier for fish caught at the Cobb Seamount.

Another surprising discovery in the Cobb Seamount fish was that more than 20% of the otoliths (used for age determination) showed a phenomenon known as resorption. Otoliths which have experienced this phenomenon are very distinctive and have a crystalline appearance. It is not known what causes resorption to occur, but some believe it may be related to environmental stress. The average coastwide percentage of widow rockfish otoliths showing resorption is less than 2%; hence, this difference between coastal and Cobb Seamount widows presents a puzzle. This phenomenon also provides a natural marker which distinguishes catches from the Cobb Seamount.

Some other observations from the Cobb Seamount are worth noting. A single rosy rockfish, *S. rosaceous*, a species which is rare north of California, was caught using hook-and-line gear and was near record length (35 cm total length). Similarly, shortbelly rockfish, *S. jordani*, are not abundant north of the California/Oregon border; however, several have been caught at record or near-record lengths. More than 20 kg of harlequin rockfish, *S. variegatus*, were landed: this is believed to be a southern extension of its range by about 200 miles. A rock sole with unusual characteristics has also been discovered; it may be a hybrid. In contrast to these discoveries, yellowtail rockfish, *S. flavidus*, a species typically caught with widow rockfish in Oregon, has not yet been caught in the Cobb Seamount.

Further examination of the Cobb Seamount fish is planned in conjunction with the Oregon Department of Fish and Wildlife. The studies will include the examination of additional otoliths, stomach-content analysis from the commercial fisheries, and further examination of the species composition. (Don Pearson, FTS 556-0565)

## GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

### Laboratory Experiments on Maternal-Embryonic Nutrition in Yellowtail Rockfish

Research on the Cordell Bank population of yellowtail rockfish, *Sebastes flavidus*, over the last six reproductive cycles indicates the possibility of maternal inputs to developing embryos. In particular, data from serum and ovaries suggests that phospholipids and vitellogenin are supplied to embryos from maternal sources during gestation as well as during the period of exogenous vitellogenesis prior to fertilization. To elucidate the extent of this transfer and to determine its importance to embryogenesis, laboratory experiments will be conducted during this reproductive cycle at the University of California, Bodega Marine Laboratory.

One experiment will assess the translocation of phospholipids from maternal serum to embryos during the course of gestation. Females will be injected intravenously with $^{14}$C-phosphatidylcholine as soon as it is practicable after fertilization. Subsequently, at about 5-day intervals, samples of embryos and serum will be withdrawn and assessed for radioactivity until the end of gestation. Concurrently, from separate pregnant females, embryos in sequential stages of development will be withdrawn by catheter and incubated in vitro in medium containing radio-labeled phospholipid. Both embryos and respired $CO_2$ will be measured for activity to determine the extent of incorporation into tissue and the extent of substrate oxidation.

A second experiment will be conducted to attempt to determine the importance of maternal feeding during gestation on the development and composition of embryos. Pregnant females will be subjected to one of three feeding regimes: (1) high lipid, (2) low lipid, high protein [isocaloric with (1)], and (3) no food for the duration of gestation [about 30-35 days]. At 5-day intervals, females will be anesthetized and embryo and serum samples will be taken by catheter and in-dwelling cannula, respectively. Embryo samples will be staged, assessed for yolk, oil, and tissue content, and analyzed for lipid and protein compositions. Serum will be assessed for proteins, vitellogenin, and lipid classes (triacylglycerols, nonesterified fatty acids, esters, cholesterol, phospholipids). At the end of the experiment, females will be examined for nutritional condition and fecundity will be estimated. Data will be analyzed to see if maternal nutrition and feeding quality during pregnancy has any impact on embryo development or energy content. (R. Bruce MacFarlane, FTS 556-0565)

### Hook-and-line Study of Cordell Bank, California, Completed

Between 1986 and 1991, researchers of the Physiological Ecology Investigations collected finfish by hook and line at Cordell Bank, California, as part of a study of reproduction and physiological condition of yellowtail rockfish, *Sebastes flavidus*. Fishing effort as well as number of fish caught were recorded and summarized in order to characterize the fish community.

Cordell Bank is the northern most of a series of seamounts located off the California coast. It lies approximately 37 km from the coastline and is only 18 fm at its shallowest depth (Figure 1). Both commercial and recreational fishermen frequent the bank, but they are primarily restricted to hook-and-line fishing because of the untrawlable, diverse rocky bottom. Collections of this study were mostly concentrated in the northern half of the bank (Figure 1), with an average bottom depth of 47 fm (range = 34-74 fm).

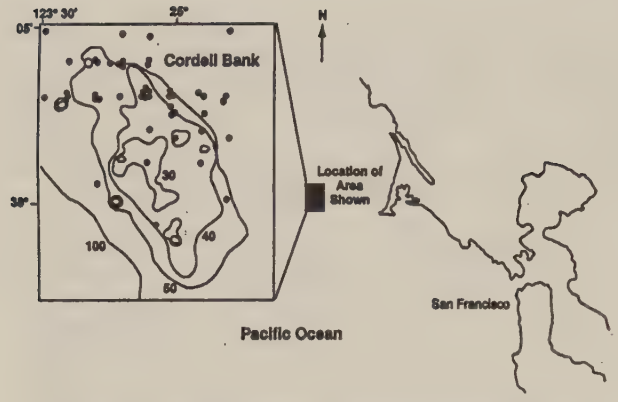


Figure 1. Fishing locations of finfish caught by hook and line at Cordell Bank, off the northern California coast.

A total of 45 trips was made at approximate monthly intervals. Each calendar month was represented by an average of 3.8 trips, made over 4 years. The interannual effort was not consistent, however, as only four trips were made in 1989 and three in 1991. Twelve complete monthly samplings were possible during 1987 and 1990. The daily collections consisted of an average 3.9 h of continuous fishing, beginning at approximately mid-morning (mean starting time 0949). The mean number of fishermen over that period was 11.5 persons.

The total number of fish landed during the study was 7403, with an average catch of 162 fish per trip

Table I. Names, total catches, mean catches per trip, and the maximum numbers caught per trip of fishes collected by hook and line at Cordell Bank, California, from 1986-91.

| Common Name | Scientific Name | Total Catch | Mean Catch Per Trip | Maximum Catch Per Trip |
|---|---|---|---|---|
| Spiny dogfish | *Squalus acanthias* | 1 | .02 | 1 |
| Chinook salmon | *Oncorhynchus tshawytscha* | 3 | .07 | 1 |
| Lingcod | *Ophiodon elongatus* | 287 | 6.38 | 33 |
| Greenspotted rockfish | *Sebastes chlorostictus* | 381 | 8.47 | 83 |
| Starry rockfish | *S. constellatus* | 143 | 3.18 | 9 |
| Greenstriped rockfish | *S. elongatus* | 32 | .71 | 15 |
| Widow rockfish | *S. entomelas* | 375 | 8.33 | 182 |
| Yellowtail rockfish | *S. flavidus* | 3492 | 77.60 | 247 |
| Chilipepper rockfish | *S. goodei* | 47 | 1.04 | 27 |
| Squarespot rockfish | *S. hopkinsi* | 2 | .04 | 1 |
| Cowcod rockfish | *S. levis* | 1 | .02 | 1 |
| Quillback rockfish | *S. maliger* | 2 | .04 | 2 |
| Vermillion rockfish | *S. miniatus* | 14 | .31 | 3 |
| Blue rockfish | *S. mystinus* | 36 | .80 | 15 |
| China rockfish | *S. nebulosus* | 1 | .02 | 1 |
| Speckled rockfish | *S. ovalis* | 134 | 2.98 | 34 |
| Bocaccio rockfish | *S. paucispinis* | 717 | 15.93 | 58 |
| Canary rockfish | *S. pinniger* | 308 | 6.84 | 82 |
| Redstripe rockfish | *S. proriger* | 1 | .02 | 1 |
| Rosy rockfish | *S. rosaceus* | 725 | 16.11 | 68 |
| Greenblotched rockfish | *S. rosenblatti* | 18 | .40 | 15 |
| Yelloweye rockfish | *S. ruberrimus* | 110 | 2.44 | 10 |
| Stripetail rockfish | , *S. saxicola* | 2 | .04 | 2 |
| Olive rockfish | *S. serranoides* | 521 | 11.58 | 109 |
| Jack mackerel | *Trachurus symmetricus* | 25 | .56 | 12 |
| Pacific mackerel | *Scomber japonicus* | 14 | .31 | 14 |
| Pacific sanddab | *Citharichthys sordidus* | 1 | .02 | 1 |
| Rock sole | *Lepidopsetta bilineata* | 10 | .22 | 3 |

(range = 48-472). The catch consisted of 28 different species, but the most represented on any given trip was 13 species. The mean number of species per trip was 10. No monthly differences in the number of species caught were found, but between-year differences were noted (analysis of variance [ANOVA] P>.01). The number of species caught in 1990 was high, but it was low in 1986, 1987, and 1988. The fish community appeared dominated by the rockfishes; of the 28 species landed, 21 were *Sebastes* species (Table 1). Together they comprised 95.6% of all fish landed. The most abundant fish caught was the yellowtail rockfish (47% of total catch), which was the target species of the study. Following the yellowtail rockfish in major abundance were *S. rosaceus* (9.8%), *S. paucispinis* (9.7%), *S. serranoides* (7.0%), and *S. chlorostictus* (5.1%). The only non-rockfish that was numerous and frequently landed was the lingcod, *Ophiodon elongatus*.

Cordell Bank was found to have a diverse and plentiful fish community that was relatively stable seasonally and for all five years studied. The research plans of the Physiological Ecology Investigations Group include continued sampling at Cordell Bank on a periodic basis, with monitoring of the yellowtail rockfish during their annual reproductive season. (Maxwell Eldridge, FTS 556-0565)

# INFORMATION TECHNOLOGY SERVICES

La Jolla, California

## ITS Hosts Southwest Regional Area Data Managers Meeting

The Southwest Fisheries Science Center (SWFSC) Information Technology Services (ITS) hosted the first annual Southwest Regional Area Data Managers meeting at the La Jolla Laboratory on December 10, 1991. The objectives of the meeting were to exchange information on the operations at each site, to discuss information technology issues, and to develop a network among the laboratories for consultation on resolving common problems and for sharing information of common interest.

In the absence of Center Director Dr. Izadore Barrett, Deputy Director Richard Neal welcomed the guests. Attending the meeting, chaired by Dorothy Roll, were Jerry Hornof (Southwest Region--Terminal Island), Donald Tieman (Honolulu), Pete Adams and Nancy Wiley (Tiburon), Roy Mendelssohn (Monterey), Richard Charter (Coastal Fisheries Resources Division), Ken Wallace (Pelagic Fisheries Resources Division/Fishery-Marine Mammal Interactions Division), and Rob Bistodeau, Matt Bones, Susan Jacobson, and Frank Ralston (Information Technology Services).

The interactive meeting session began with a briefing on site operations and staffing structure by the managers from each laboratory, division, and office. Following this briefing with discussions on budget constraints/concerns at each site, the group focused on technology issues. The topics included the plans for upgrading the 3COM Local Area Network (LAN) to Microsoft LAN Manager, the National Marine Fisheries Service (NMFS) Headquarter's planned conversion of 3COM EMAIL to cc:MAIL, LAN access to the Financial Reporting System (FRS), the FTS2000 and Internet issues, software/hardware trends, standards issues, and computer virus awareness. Proposed for building a strong network among the data managers and the Southwest Regional user community are electronic mail exchanges among the sites and the re-birth of *Fish 'n' Chips*, the Southwest Fisheries Service Center computer newsletter. News items will include resolution of problems, notice of virus alerts and attacks, experience with new software versions, comments on software/hardware trends in the private, academic, and government sectors, and client-server technology. (Dorothy D. Roll, (619) 549-7057)

## National Marine Fisheries Service Sponsors Security Plans Workshop at La Jolla Laboratory

By mandate under the Computer Security Act of 1987 and OMB Circular A-130, all sites with computers (mainframes and microcomputers) handling sensitive data must prepare and submit disaster-recovery plans and risk-analysis reports to the National Oceanic and Atmospheric Administration (NOAA). To assist the remote-site data systems managers in complying with this mandate, the National Marine Fisheries Service (NMFS) Headquarters Office sponsored security plan workshops at the four regional sites during November and December 1991.

The workshop for the Southwest Regional Area was held on December 11, 1991, at the La Jolla Laboratory. Attending were Jerry Hornof (Southwest Region--Terminal Island), Donald Tieman (Honolulu), Roy Mendelssohn (Monterey), Nancy

Wiley (Tiburon), Richard Charter (Coastal Fisheries Resources Division), Ken Wallace (Pelagic Fisheries Resources Division), Chuck Oliver (Fishery-Marine Mammal Interactions Division), Roger Hewitt (Antarctic Ecosystem Research Group), and Rob Bistodeau, Matt Bones, Susan Jacobson, Frank Ralston, and Dorothy Roll (Information Technology Services). Jackie Greenawalt from the National Marine Fisheries Service Office of Research and Environmental Information, Data Management Division, conducted the training session on developing the system-security plans. She briefed the group on Department of Commerce/National Oceanic and Atmospheric Administration's (NOAA) computer-security policies, responded to questions, stepped through the elements in the NOAA security plan format, and distributed approved plans submitted by other agencies as examples.

Security plans must be developed for General Support Systems and Major Applications. These system-security plans will serve as a documentation of the structured process of planning adequate, cost-effective security protection for the identified systems to ensure against loss, misuse, unauthorized access or modification, unavailability, or undetected activities. The completed plans from each site will be forwarded to Greenawalt for integration into the National Marine Fisheries Service package for submission to the National Oceanic and Atmospheric Administration Security Officer. (Dorothy D. Roll, (619) 546-7057)

## 1991 PUBLICATIONS

### Published

This **Published** list encompasses publications for the entire year of 1991 for the Southwest Fisheries Science Center. In press publications are not listed here.


Adams, Peter B., and Wayne M. Samiere. 1991. A computerized "expert system" to aid in the identification of juvenile rockfish (Genus *Sebastes*). *In* Laidig, Thomas E., and Peter B. Adams (editors), Methods used to identify pelagic juvenile rockfish (genus *Sebastes*) occurring along the coast of central California. p. 47-57. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-166.

Alheit, J., and A. Bakun. 1991. Reproductive success of sprat, *Spratus spratus*, in German Bight during 1987. ICES DOC. C.M. 1991/L:44. Theme session on the Sardine-Anchovy Recruitment Project (SARP). 79th ICES Statuatory Meeting, La Rochelle, France, 26 September-2 October, 1991. 12 p.

Bakun, A. , J. Alheit, and G. Kullenberg. 1991. The Sardine-Anchovy Recruitment Project: Rationale, design and development. ICES DOC. C.M. 1991/L:43. Theme session on the Sardine-Anchovy Recruitment Project (SARP). 79th ICES Statuatory Meeting, La Rochelle, France, 26 September-2 October, 1991. 18 p.

Bakun, A., and C. S. Nelson. 1991. Wind stress curl in subtropical eastern boundary current regions. J. Phys. Oceanogr. 21(12):1815-1834.

Bakun, A., C. Roy, and P. Cury. 1991. The comparative approach: Latitude dependence and effects of wind forcing on reproductive success. ICES DOC. C.M. 1991/L:45. Theme session on the Sardine-Anchovy Recruitment Project (SARP). 79th ICES Statuatory Meeting, La Rochelle, France, 26 September-2 October, 1991. 12 p.

Balazs, G. H. 1991. Sea turtle tag center of the Pacific. Mar. Turtle Newsl. 52:14-15.

Balazs, G. H., and S. G. Pooley (editors). 1991. Research plan for marine turtle fibropapilloma. Results of a December 1990 workshop. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-156, 113 p.

Barlow, Jay, and Peter Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mammal Sci. 7(1):50-65.

Boehlert, G.W. 1991. A review of ichthyoplankton around oceanic islands and seamounts and the mechanisms important in recruitment. Fourth Congress of Marine Science in Coquimbo, Chile, October 1-5, 1991. (Abstract)

Boehlert, G.W. 1991. Horizontal and vertical distributions of larval fishes around an isolated oceanic island in the tropical Pacific. Fourth Congress of Marine Science in Coquimbo, Chile, October 1-5, 1991. (Abstract)

Boehlert, G.W. 1991. Southwest Fisheries Science Center Honolulu Laboratory, p. 147-148. *In* C. D. Becker (editor), Fisheries Laboratories of North America. Am. Fish. Soc., Bethesda, MD.

Boehlert, G. W., and J. Yamada. 1991. Introduction to the symposium on rockfishes. *In* Boehlert, G. W., and J. Yamada (editors), Rockfishes of the genus *Sebastes*: their reproduction and early life history, p. 9-14. Environ. Biol. Fish. 30(1-2).

Boehlert, G. W., and J. Yamada (editors). 1991. Rockfishes of the genus *Sebastes*: their reproduction and early life history. Environ. Biol. Fishes 30(1-2):1-288.

Boehlert, George W., Muneharu Kusakari, and Juro Yamada. 1991. Oxygen consumption of gestating female *Sebastes schlegeli*: estimating the reproductive costs of livebearing. *In* G. W. Boehlert and J. Yamada

(editors), Rockfishes of the genus *Sebastes*: their reproduction and early life history, p. 273-280. Environ. Biol. Fishes 30(1-2):81-89.

Boehlert, G. W., M. S. Love, J. P. Wourms, and J. Yamada. 1991. A summary of the symposium on rockfishes and recommendations for future research. *In* G. W. Boehlert and J. Yamada (editors), Rockfishes of the genus *Sebastes*: their reproduction and early life history, p. 81-90. Environ. Biol. Fishes 30(1-2).

Boggs, Christofer H. 1991. Bioenergetics and growth of northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 89:555-566.

Changes in total body energy content of adult (total length ca. 9 cm, wet mass ca. 9 g) northern anchovy, *Engraulis mordax*, were estimated by sampling captive groups swimming at 8.7 and 21.1 cm/s for 12 hours daily. Anchovy were fed euphausiids at rations of 5 and 3.4% of fish wet mass per day (ca. 54 and 37 cal·g fish wet mass$^{-1}$·day$^{-1}$, respectively). Gross energy conversion efficiency increased with ration levels and declined with swimming speed, ranging from 39% to 1%. Dry mass and lipid losses were estimated in fasting fish swimming at the same speeds. Energy losses were 17.6 and 28.2 cal·g fish wet mass$^{-1}$·day$^{-1}$ at the slow and fast speeds, respectively. The proportion of food energy used for growth and maintenance metabolism was about 65%. A model derived for adult anchovy metabolism was consistent with observed growth and reproduction rates, and the few measurements of ration and swimming speed in nature.

Bowlby, C. Edward, Penelope D. Scoggins, Rodney T. Watson, and Michelle L. Reddy. 1991. Hawaiian monk seal, *Monachus schauinslandi*, at Kure Atoll, 1982-83. U.S. Dep. Commer., NOAA Tech. Memo, NOAA-TM-NMFS-SWFSC-155, 29 p.

Brill, R. W., and P. G. Bushnell. 1991. Metabolic and cardiac scope of high energy demand teleosts, the tunas. Can. J. Zool. 69:2002-2009.

The maximum aerobic metabolic rates of tunas are far above those of other fishes. In this review, we attempt to define features of the cardiovascular system that may account for this extreme performance. Tuna hearts are much larger than those of most other fishes and are half the mass of those of similarly sized mammals; however, the ratio of compact to spongy myocardium is not higher than in other active teleosts (except for one tuna species). Myocardial aerobic enzyme activity levels are not significantly elevated. The cardiac outputs of spinally blocked skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*, are roughly four times those of other active teleosts. Ventral aortic blood pressures are the highest among all fishes (more than twice those of rainbow trout, *Oncorhynchus mykiss* (formerly *Salmo gairdneri*), and appear to be due to a high resistance to blood flow in the gills since dorsal aortic blood pressures are not exceptional. Heart rates, cardiac output, and ventilation volume are high, but gill ventilation and perfusion appear to be well matched (i.e., gill ventilation: perfusion conductance ratios of 1). Blood hemoglobin concentrations of tunas are elevated, essentially identical with those of humans and twice those seen in other fishes. Because their blood oxygen-carrying capacity is high and because skipjack and yellowfin tunas appear to be able to increase the minimum-observed arterial-to-venous oxygen content differences by approximately three times, we predict that they need to increase cardiac output only about two times during maximum rates of oxygen uptake. This ratio is not very different from those of other teleosts.

Brill, R. W., and P. G. Bushnell. 1991. Effects of open- and closed-system temperature changes on blood oxygen dissociation curves of skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*. Can. J. Zool. 69:1814-1821.

Tunas often experience rapid temperature changes of 10°C or more during their daily vertical movements. Their blood is therefore subjected to open-system (i.e., constant $O_2$ and $CO_2$ partical pressure, variable $O_2$ and $CO_2$ content) temperature changes during passage through the gills. In addition, tunas possess vascular countercurrent heat exchangers and can have deep red muscle temperatures as much as 20°C above ambient. Their blood also experiences closed-system (i.e., constant $O_2$ and $CO_2$ content, variable $O_2$ and $CO_2$ pressure) temperature changes during passage through the heat exchangers. Temperature-independent blood $O_2$ binding can be expected. We found blood oxygen dissociation curves of skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*, to be temperature independent during open-system temperature changes. Although blood from both species showed unusually large Bohr effects (-0.986 and -0.865 $\Delta\log P_{50} \cdot \Delta pH^{-1}$ for skipjack and yellowfin tuna, respectively) when subjected to $CO_2$ partial-pressure alterations in the open system, the oxygen dissociation curves of skipjack tuna blood were nearly temperature independent during closed-system temperature changes. In other words, blood from skipjack tuna showed a reduced Bohr effect when subjected to the inevitable $CO_2$ partial-pressure changes that accompany closed-system temperature changes whereas yellowfin tuna blood does not. This unusual feature is not obligatory in thermoconserving fishes.

Bushnell, P.G., and R.W. Brill. 1991. Responses of swimming skipjack, *Katsuwonus pelamis*, and yellowfin, *Thunnus albacares*, tunas to acute hypoxia, and a model of their cardiorespiratory function. Physiol. Zool. 64(3):787-811.

Butler, J. L. 1991. Mortality and recruitment of Pacific sardine, *Sardinops sagax caerulea*, larvae in the California Current. Can. J. Fish. Aquat. Sci. 48:1713-1723.

The mortality rates of Pacific sardine, *Sardinops sagax caerulea*, larvae (<20 d) increased during 1951-67, and

this increase was positively correlated with the increase in biomass of northern anchovy, *Engraulis mordax*. Other potential correlates with larval sardine mortality rates were examined using multiple correlation. These included terperature and zooplankton volumes at stations positive for sardine larvae, water column stability, upwelling, transport, salinity anomalies, and Pacific mackerel, *Scomber japonicus*, abundance. None contributed significantly to the multiple regression with anchovy abundance. Thus, no evidence existed for either Lasker's stable ocean hypothesis of larval mortality or Hjort's larval transport hypothesis. The logarithm of the ratio of sardine recruits at age 2 to the spawning biomass was used as an index of recruitment success. Sardine recruitment success at age 2 was not correlated with larval mortality rates. Sardine recruitment, however, was negatively correlated with both northern anchovy biomass and the combined biomass of Pacific sardine, Pacific mackerel, and northern anchovy. A plausible explanation for this result is that predation by pelagic fishes results in greater mortality rates of sardine larvae and juveniles which in turn decreases sardine recruitment.

Butler, J. L., W. W. Wakefield, P. B. Adams, B. H. Robison, and C. H. Baxter. 1991. Application of line-transect methods to survey demersal communities with ROVs and manned submersibles. Proceedings of the Oceans 91 Conference, Honolulu, Hawaii, October 1-3, 1991. p. 689-696.

The traditional method of estimating the abundance of demersal fishes is the swept-area trawl method. This method has many biases and is limited to smooth bottom surfaces. The Southwest Fisheries Science Center is developing innovative stock assessment methodology to improve population estimates of important fishery resources in the U. S. Exclusive Economic Zone (EEZ). Manned submersibles or remotely operated vehicles (ROVs), equipped with both still and video cameras will be used to record images along sea-floor transects. This method will allow for sampling of areas unavailable to traditional methods (e.g. rocky substrate). Line transect estimates from the survey vehicle will be compared to traditional trawl estimates on trawlable substrate. Density estimates obtained from samples stratified by depth and bottom roughness will be used to make population estimates using stratum areas quantified by multibeam surveys. Integrating habitat- specific estimates of fisheries resources with multibeam data will provide a new application for existing NOAA multibeam sonar data, as well as ensure previously unattainable precision in fishery assessment. Survey data will provide in situ evidence of habitat use by fishery resources. The analysis of trawl tracks will document the effect of man's activities (trawling) on this habitat.

Conte, Frank P., Kazunori Takano, Akihiro Takemura, and George W. Boehlert. 1991. Ontogeny of the sodium pump in embryos of rockfish of the genus *Sebastes*. *In* G. W. Boehlert and J. Yamada (editors), Rockfishes of the genus *Sebastes*: their reproduction and early life history. Environ. Biol. Fishes 30(1-2):127-134.

Davenport, John, and George H. Balazs. 1991. "Fiery bodies"--Are pyrosomas an important component of the diet of leatherback turtles? Br. Herpetol. Soc. Bull. 37:33-38.

DeMartini, E. E. 1991. Annual variations in fecundity, egg size, and the gonadal and somatic conditions of queenfish, *Seriphus politus* (Sciaenidae). Fish. Bull., U.S. 89:9-18.

Dizon, Andrew E., Sárka O. Southern, and William F. Perrin. 1991. Molecular analysis of mtDNA types in exploited populations of spinner dolphins *Stenella longirostris*. Rep. Int. Whal. Commn (Special Issue 13), SC/S89/Gen11, pp. 183-202.

Duffield, D. A., J. Chamberlin-Lea, J. C. Sweeney, D. K. Odell, E. D. Asper, and W. G. Gilmartin. 1991. Use of corneal cell culture for R-band chromosome studies on stranded cetaceans. *In* J. E. Reynolds and D. K. Odell (editors), Marine mammal strandings in the United States, p. 91-100. Proceedings of the Second Marine Mammal Stranding Workshop, Miami, Florida, December 3-5, 1987.

Edwards, Elizabeth F., and Pierre M. Kleiber. 1991. CHARTOPS: Simulating short-term use of the tuna purse seine fleet to survey dolphin schools in the eastern tropical Pacific Ocean. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-163, 22p.

Eldridge, Maxwell B., Jeannette A. Whipple, Michael J. Bowers, Brian M. Jarvis, and Jordan Gold. 1991. Reproductive performance of yellowtail rockfish, *Sebastes flavidus*. Environ. Biol. Fish. 30:91-102.

Forney, Karin A., Doyle A. Hanan, and Jay Barlow. 1991. Detecting trends in harbor porpoise abundance from aerial surveys using analysis of covariance. Fish. Bull., U.S. 89:367-377.

Gerrodette, Tim. Models for power of detecting trends--a reply to Link and Hatfield. Ecology 72(5):1889-1892.

Gerrodette, Tim, and William G. Gilmartin. 1991. Demographic consequences of changed pupping and hauling sites of the Hawaiian monk seal. Conserv. Biol. 4(4):423-430.

Gordoa, Ana C., and Joseph E. Hightower. 1991. Changes in catchability in a bottom-trawl fishery for Cape hake, *Merluccius capensis*. Can. J. Fish. Aquat. Sci. 48:1887-1895.

Management of the Cape hake, *Merluccius capensis*, stock off the coasts of Angola and Namibia has been based on surplus production modeling, which incorporates an assumption of constant catchability. Results of least-squares catch-at-age analysis and virtual population analysis were used to estimate

catchability from 1968 to 1986. Estimated catchability was either relatively constant or gradually increasing from 1968 to 1978 but fluctuated considerably between about 1979 and 1983. The fluctuations may have been due to an inverse relationship between catchability and abundance or to environmental factors affecting fish distribution. The period of highest estimated catchability corresponded to the period of lowest estimated abundance and below-average water temperatures. If management is based on the assumption of constant catchability, but catchability is inversely related to abundance, the risk of overfishing will be greatest when the stock is at the lowest levels. Future assessments should place increased reliance on survey data or incorporate an appropriate model of catchability changes.

Henderson, J. R. 1991. Book review: Seabirds of Hawaii: Natural history and conservation, by Craig S. Harrison. Hawaii. J. Hist. 25:222-224.

Hewitt, R. P. 1991. Krill abundance. Nature. 353:310. In-situ measurements of individual krill target strength are presented (modal value=-69 db). Net samples obtained immediately before the experiment indicate that the animals were reproductively mature and averaged 47.44mm in length. Results agree well with recent predictions of acoustic target strength based on extrapolations of other field experiments using the bent cylinder model of sound scattering by elongated zooplankters. The modal value of the measurements is 6.7dB lower than that predicted by the BIOMASS equation for 47.44mm krill.

Hill, P. Scott, Randall C. Rasmussen, and Tim Gerrodette. 1991. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *David Starr Jordan*, July 28-December 6, 1990. U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-158, 133 p.

Hill, P. Scott, Randall C. Rasmussen, and Tim Gerrodette. 1991. Report of a marine mammal survey of the eastern tropical Pacific aboard the research vessel *McArthur*, July 28-December 6, 1990. U. S. Dep. Commer., NOAA Tech. Memo, NOAA-TM-NMFS-SWFSC-159, 142 p.

Kramer, Sharon Hendrix. 1991. Growth, mortality, and movements of juvenile California halibut, *Paralichthys californicus*, in shallow coastal and bay habitats of San Diego County, California. Fish. Bull., U.S. 89(2):195-207.

Kramer, Sharon Hendrix. 1991. The shallow-water flatfishes of San Diego County. Calif. Coop. Oceanic Fish. Invest. Rep. 32:128-142.

Seven species of flatfish live in the shallow marine waters (depth 14 m) of San Diego County: California halibut, *Paralichthys californicus*; fantail sole, *Xystreurys liolepis*; speckled sandab, *Citharichthys stigmaeus*; spotted turbot, *Pleuronichthys ritteri*; hornyhead turbot, *Pleuronichthys verticalis*; diamond turbot, *Hypsopsetta guttulata*; and California tonguefish, *Symphurus atricauda*. Speckled sanddab was most abundant, representing 79% of the flatfish catch. California halibut had the highest biomass and represented 46% of the catch.

Only California halibut and diamond turbot used bays as nursery areas; they had distinct ontogenetic distributions, with length increasing with depth. The remaining species settled on the open coast but were not found together during early juvenile stages; they settled at different depths and at different times of the year. Older juveniles and adults partitioned the habitat by eating different foods and by living at different depths and locations.

Life histories of nearshore flatfishes varied widely: speckled sanddab settled at a large size on the open coast and matured rapidly, whereas California halibut settled at a small size, used bays as nurseries, and delayed maturity.

Laidig, Thomas E., and Peter B. Adams (editors). 1991. Methods used to identify pelagic juvenile rockfish (Genus *Sebastes*) occurring along the coast of central California. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-166, 180 p.

Laidig, Thomas E., and Peter B. Adams. 1991. Introduction: Methods used to identify pelagic juvenile and larval rockfish (genus *Sebastes*) occurring along the coast of central California. *In* Laidig, Thomas E., and Peter B. Adams (editors), Methods used to identify pelagic juvenile rockfish (genus *Sebastes*) occurring along the coast of central California, p. 1-5. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-166.

Laidig, Thomas E., Stephen Ralston, and James R. Bence. 1991. Dynamics of growth in the early life history of shortbelly rockfish, *Sebastes jordani*. Fish. Bull., U. S. 89(4):611-621.

The relationship between length and age of larval and juvenile shortbelly rockfish, *Sebastes jordani*, determined from otolith microstructure, is complex. Models that assume size increases smoothly with age may not accurately describe growth in young-of-the-year rockfish. A segmented (piece-wise linear) regression model relating somatic and otolith size was used to back-calculate body length-at-age. The segments of this model coincide with different growth stanzas, which are separated by distinct life-history transitions. The composite function of this model, and a Gompertz curve relating otolith size and age, yielded a good fit to the back-calculated standard length-at-age data. Comparison of back-calculated with actual growth showed no evidence of size-selective mortality. The change in body length, as the number of otolith increments increased, was equal to the observed increase in length per day of a sequentially sampled cohort, validating the daily periodicity of the increments.

Laidig, Thomas E., and Wayne M. Samiere. 1991. Pigment patterns of juvenile *Sebastes flavidus* and *Sebastes melanops* useful in identification. *In* Laidig, Thomas E., and Peter B. Adams (editors), Methods used to identify pelagic juvenile rockfish (genus *Sebastes*) occurring along the coast of central California, p. 7-18. U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-166.

Laidig, Thomas E., Wayne M. Samiere, and Ralph C. DeFelice. 1991. The use of the bones of the caudal complex to identify juvenile rockfish (*Sebastes* spp.). *In* Laidig, Thomas E., and Peter B. Adams (editors), Methods used to identify pelagic juvenile rockfish (genus *Sebastes*) occurring along the coast of central California, p. 31-46. U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-166.

Lenarz, William H. and Tina Wyllie Echeverria. 1991. Sexual dimorphism in *Sebastes*. Environ. Biol. Fish 3:71-80.

Lenarz, William H., Ralph J. Larson, and Stephen Ralston. 1991. Depth distributions of late larvae and pelagic juveniles of some fishes of the California Current. Calif. Coop. Oceanic Fish. Invest. Rep. 32:41-46.

Lowry, Mark S., Brent S. Stewart, Carolyn B. Heath, Pamela K. Yochem, and John M. Francis. 1991. Seasonal and annual variability in the diet of California sea lions, *Zalophus californianus*, at San Nicolas Island, California, 1981-86. Fish. Bull., U.S. (Note) 89(2):331-336.

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Genetic relationships and distribution patterns among populations, subspecies, and species of northeastern Pacific myxodin clinids were analyzed from allozyme data. The most recent revision recognized 6 species and 12 subspecies in 2 genera, *Heterostichus* and *Gibbonsia*. Allozymes from 40 gene loci from all 12 nominal taxa were analyzed to compare heterozygosity levels, Hardy-Weinberg equilibrium conformance, genetic distances, and phylogenetic relationships. Sample sites ranged from Carmel, California, to central Baja California, Mexico, and included areas of sympatry, disjunct distribution, and relative isolation. Offshore island sites included the California Channel, San Benito, and Guadalupe islands; the last with several endemic nominal taxa. In addition, morphological characters putatively defining closely related taxa were reexamined because preliminary data suggested that some taxonomic separations had been made on the basis of sexually dimorphic characters and ecophenotypic variation.

Most intraspecific samples shared close genetic relationship, consistent with little genetic isolation. Disjunct populations of *G. montereyensis* and *G. metzi* from north of Point Conception, California, and in areas of cold water upwelling off northern Baja California, Mexico, respectively, are very similar. The Channel Island populations are little divergent from those of the mainland; however, the San Benito Islands' population is slightly more genetically distinct. Populations of the geographically isolated Guadalupe Island are genetically divergent. Patterns of genetic relationships among populations may be explained by the relatively long larval life of clinids (up to 2 months), geographic continuity, and major coastal current patterns. Some allelic variation in *G. elegans*, *G. montereyensis*, and *G. metzi* also supports longitudinal clinal trends, which may suggest selection resulting from temperature.

Both allozyme and morphological data failed to separate *G. erythra* from *G. montereyensis*. *Gibbonsia erythra* is a deepwater ecophenotype of *G. montereyensis*; males inhabit deeper water than females, and the supposed distinguishing characters are sexually dimorphic and/or depth related. *Gibbonsia norae* is a semi-isolated population of *G. montereyensis* inhabiting the San Benito and Guadalupe islands, Mexico. A new key to the northeastern Pacific Clinidae is given.

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## Administrative Reports

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